U.S. Mines, Bur. of

Technical Paper 103

DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, SECRETARY

BUREAU OF MINES
VAN. H. MANNING, DIRECTOR

# ORGANIZING AND CONDUCTING SAFETY WORK IN MINES

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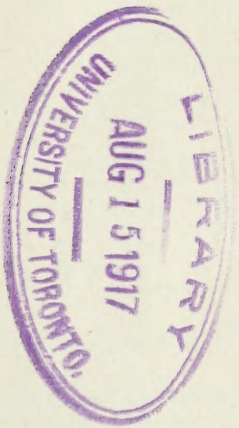
ENGINEERING

ENGIN STORAGE

BY

HERBERT M. WILSON
AND
JAMES R. FLEMING




WASHINGTON
GOVERNMENT PRINTING OFFICE
1917

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*First edition. March, 1917.*

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# ORGANIZING AND CONDUCTING SAFETY WORK IN MINES.

By Herbert M. Wilson and James R. Fleming.

## INTRODUCTION.

During the past few years there has been marked progress in safety work by mining companies. Such work has usually been started and directed by an executive, with the aid and advice of individuals or committees reporting to him, independently of the operating department. The practice has been to awaken the interest of the employees in the causes, results, and avoidance of accidents; to convince them of the genuine desire of the company to bring about increased safety; and to obtain the cooperation of officials and employees in suggesting and adopting protective measures.

At first there was some doubt regarding the permanency of a movement that had its inspiration in human welfare and for its prime purpose the safeguarding of life and limb. The experimental stage has passed, however, and from the united work of many hands and minds practical results are being obtained. Many mining companies have been quick to adopt the more desirable safety measures, such as the creating of safety departments and the requiring of more careful supervision at the mines. Mining laws have been greatly improved and more strictly enforced. Various local and national organizations have been formed for promoting safety and standardizing methods. The enactment by several States of workmen's compensation legislation, with the consequent insurance against casualties, has aided the safety movement. Much progress has been made in educational work through various agencies. Altogether the movement is commanding much attention and must result in saving many lives.

As has often been the outcome in movements for human welfare, additional advantages other than those anticipated at first have resulted. Accident prevention has not only meant fewer injuries and consequently less suffering and distress to miners and their families, but has increased the efficiency of plant operation, so that economic gain has followed. The present tendency is toward stand-

ardization and greater uniformity in the measures vitally affecting the safety and health of all employees. It is to be hoped that this tendency will fully crystallize, so that the valuable data furnished by experience, scientific investigation, and experiment will serve as a useful basis in solving problems that confront the mining industry.

Increasing earnestness is being shown throughout the country in organizing and establishing the permanence of industrial safety. Many industries are now making a systematic attempt to reduce accidents. If all industries engage in a similar endeavor, what may not be the benefit in one year's time with our present industrial accident record of 35,000 men killed and 2,000,000 injured annually? The value of organization and of cooperation in this work can not be computed in dollars and cents.

## PURPOSE OF THE REPORT.

The purpose of this paper is to call attention to some of the means adopted for promoting greater safety in and around mines, in the hope that their presentation will stimulate activity and aid those endeavoring to solve safety problems in the different mining fields. The paper deals primarily with the organization of safety work, which is a fundamental requirement for an effective campaign in accident prevention. Concerted action by officials and workmen is essential if this economic and humane movement is to have the success it merits.

The Bureau of Mines has received many inquiries regarding safety organization and the means of creating and sustaining interest in mine safety. To meet this demand the mining engineers of the bureau and the authors of this report have devoted much time to collecting data concerning the methods adopted by those companies that maintain safety organizations.

An endeavor has been made to arrange these data in such a way as to present a system for practical application in either large or small mines, be they coal or metal. The existing organization of every mining concern is adapted to the creation of a safety organization. New employees will be necessary only for very large operations. It is not expected that a company employing a comparatively small number of men would adopt measures on the same scale as a company having many large operations, but the same general principles apply, and any variations need be those of degree only. The expense for safety work will, of course, vary; but experience indicates that whatever the investment, it will pay a good dividend.

No special reference is made to the many mining companies, both coal and metal, that have efficient safety organizations in operation, but the recommendations presented are based on a study of these.

ACKNOWLEDGMENTS.

For the data contained in this report the Bureau of Mines expresses its indebtedness to the mining industry as a whole; for the use of illustrations it is indebted especially to the following companies: United States Steel Corporation and subsidiary mining companies; Cleveland Cliffs Iron Co.; Delaware & Lackawanna Railroad Co.; New Jersey Zinc Co.; and Anaconda Copper Mining Co.

The authors particularly desire to acknowledge advice and criticism of the manuscript by E. H. Weitzel, manager Colorado Fuel & Iron Co.; J. P. Reese, general manager of the Superior Coal Co.; William Kelly, general manager of the Penn Iron Mining Co.; C. V. Jenkins, business manager of the Steptoe Valley Smelting & Mining Co.; and C. L. Close, manager of the bureau of safety, relief, sanitation, and welfare, United States Steel Corporation.

## ORGANIZATION OF SAFETY WORK.

In organizing safety work cordial cooperation and enthusiasm are essential. The definite purpose of a safety campaign is the immediate reduction of easily preventable accidents and a gradual reduction of all accidents. The number of accidents occurring annually is convincing proof that the problem demands a vigorous and continuous campaign backed by adequate financial support, and above all by the active sympathy and energy of some of the highest officials in each mining company. Experience has proved that satisfactory conduct of a safety campaign requires organization for carrying out three branches of work, as follows:

1. An organization that provides an enthusiastic and hard-working safety committee or department, an adequate inspection system, and hearty cooperation of officials and employees.

2. A system of education that will assist all employees to follow more carefully the safe and proper methods of work and will keep them constantly alert to the need of caution.

3. A scheme of safety measures designed to eliminate as far as possible dangerous conditions that have caused accidents or may cause them.

The approximate relative values of these different factors have been estimated by R. J. Young, head of the safety department of the Illinois Steel Co., as follows: Organization, 45 per cent; education, 30 per cent; safety measures, 25 per cent.

In giving relative values to these factors the majority of the leading advocates of safety in the various industries place the greatest emphasis on organization and education. The lowest value is placed on safety measures because of their inadequacy in themselves, so far as preventing most accidents is concerned. The figures,

although a mere approximation at best, form a practical basis for promoting safety work.

## "SAFETY FIRST."

Preventable mine accidents are generally attributed to carelessness, insufficient inspection, inexperience, unsafe practices, lack of safeguards, violation of instructions, indifference, defective equipment, use of intoxicants, insufficient lighting, poor judgment, and other indirect causes. The "safety-first" movement aims at minimizing such preventable accidents. "Safety first" means simply that safety must be the first consideration during any and all parts of the day's work, that every precaution be taken to prevent accidents by making conditions as safe as possible and that the best and safest methods practicable be always employed so as to avoid unnecessary exposure to risk. The purposes of "safety first" are thoroughly practical. In some of the leading industries safety campaigns have resulted in reducing by 30 per cent, and even 70 per cent, the number of accidents that had been occurring annually for a period of years.

The initiative in safety work must be taken by the management. Usually in starting an active safety campaign the officials hold a public mass meeting at which data showing the possibilities of the work are presented to the employees.

## STATISTICS.

Statistics are of great value for study and comparison, as may be seen by carefully examining the data presented in figures 1 to 6, inclusive, and in Tables 1, 2, 3, and 4.

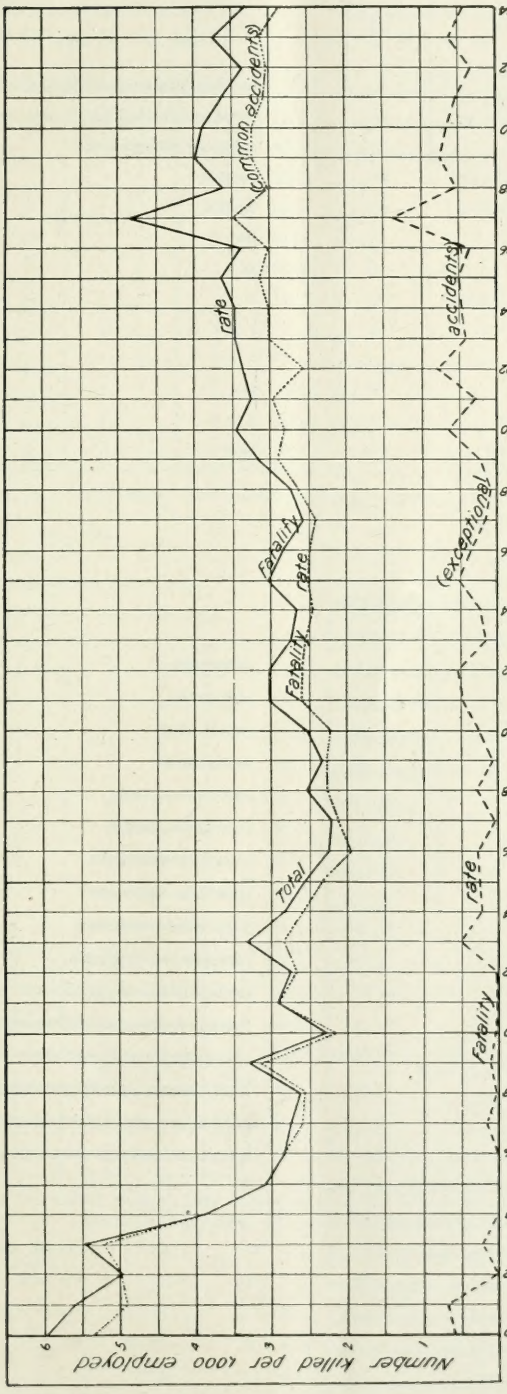


FIGURE 1.—Total number killed per 1,000 employed in coal mines of the United States; also number killed per 1,000 employed, in common and in exceptional accidents, 1870–1914.

| Cause of accident. | Number killed. | Percentage of total number killed. |
|---|---|---|
| Grand total | 2,269 | 100 |
| Total underground fatalities | 2,069 | 91.19 |
| Falls of roof and coal | 1,079 | 47.56 |
| Mine cars and locomotives | 347 | 15.29 |
| Gas and coal-dust explosions | 304 | 13.40 |
| Explosives | 155 | 6.83 |
| Electricity | 89 | 3.92 |
| Suffocation from mine gases | 16 | .71 |
| Mining machines | 12 | .53 |
| Mine fires | 1 | .04 |
| Other causes | 66 | 2.91 |
| Fatal accidents in shafts | 40 | 1.76 |
| Fatal accidents on surface | 160 | 7.05 |

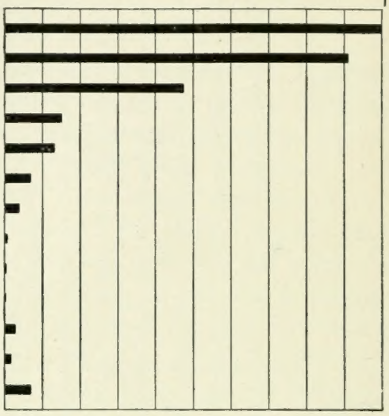


FIGURE 2.—Fatalities in and about the coal mines in the United States in 1915, by causes.

| Year. | Country. | Number employed. | Killed per 1,000 employed. |
|---|---|---|---|
| 1912 | Portugal | 7,769 | 0.93 |
| 1908 | Russia | 191,334 | .93 |
| 1912 | Austria | 20,890 | 1.00 |
| 1914 | Great Britain | 23,709 | 1.01 |
| 1912 | Italy | 48,225 | 1.47 |
| 1912 | Japan | 81,921 | 1.57 |
| 1910 | Sweden | 13,775 | 1.73 |
| 1912 | Spain | 149,884 | 1.73 |
| 1912 | Germany | 93,591 | 1.85 |
| 1912 | Greece | 6,180 | 1.94 |
| 1912 | Australasia | 66,776 | 2.47 |
| 1912 | Peru | 14,435 | 2.90 |
| 1912 | Mexico | 12,678 | 3.08 |
| 1912 | France | 31,602 | 3.29 |
| 1914 | United States | 158,115 | 3.52 |
| 1913 | Transvaal | 223,380 | 3.81 |

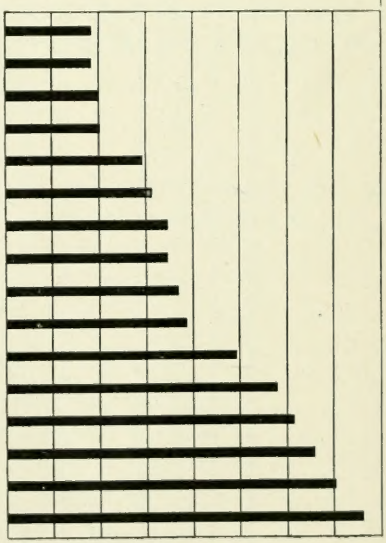


FIGURE 3.—Comparison of number of men employed and number killed per 1,000 employed in the metal mines of the principal countries.

| Cause of fatality. | Number killed. | Percentage of total number killed. |
|---|---|---|
| Grand total | 559 | 100 |
| Total underground fatalities | 366 | 65.47 |
| Fall of rock or ore | 192 | 34.35 |
| Explosives | 49 | 8.76 |
| Falling down chute, winze, raise, or stope. | 48 | 8.59 |
| Haulage | 31 | 5.55 |
| Electricity | 8 | 1.43 |
| Run of ore from chute or pocket | 5 | .89 |
| Other causes | 33 | 5.90 |
| Total shaft fatalities | 100 | 17.89 |
| Total surface fatalities | 37 | 6.62 |
| Total open-pit fatalities | 56 | 10.02 |

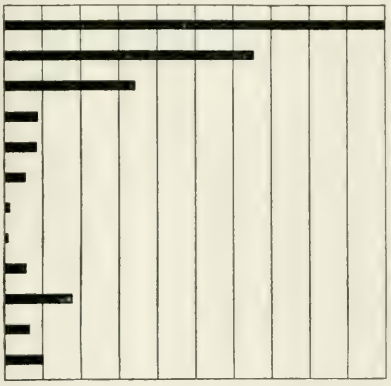


FIGURE 4.—Fatalities in and about the metal mines in the United States in 1914, by causes.

| Occupation. | Per cent. |
|---|---|
| Metal miners | 30.5 |
| Coal miners | 22.9 |
| Iron and steel workers | 15.3 |
| Machinists | 10.0 |
| Masons | 9.0 |
| Painters | 8.6 |
| Carpenters | 7.8 |
| Textile workers | 7.0 |
| Clerks | 6.7 |
| Farmers | 5.8 |

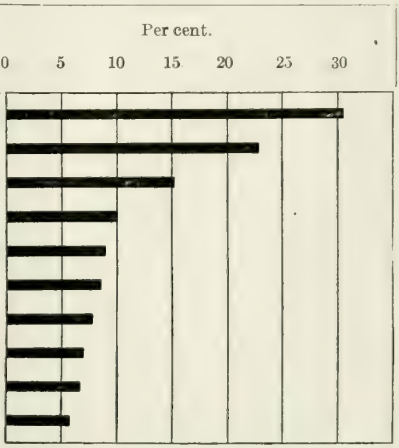


FIGURE 5.—Ratio of accidental to total deaths, 1907–1910, classified by occupations. In mining the accidental deaths form a large percentage of the total. On the basis of the ratio given, one out of three metal miners, or one out of four coal miners, meets death by accident.

| | Number of employees. | Days worked. | Number killed per 1,000 employed, based on number of 300-day workers. |
|---|---|---|---|
| Gold and miscellaneous metal mines. | 48,438 | 273 | 4.06 |
| Iron mines | 44,807 | 262 | 3.78 |
| Copper mines | 44,686 | 287 | 3.85 |
| Lead and zinc mines (Mississippi Valley). | 10,935 | 254 | 4.32 |
| Miscellaneous mineral mines. | 9,249 | 235 | 3.72 |
| All mines other than coal. | 158,115 | 271 | 3.92 |
| Coal mines | 763,185 | 207 | 4.67 |
| Quarries | 87,936 | 233 | 2.64 |

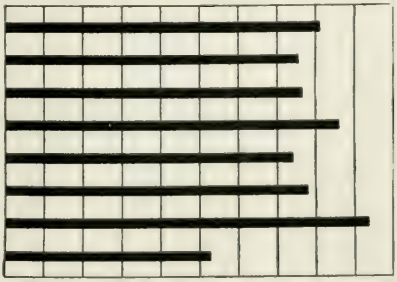


FIGURE 6.—Comparison of fatality rates in different kinds of mines in the United States during 1914.

Table 1 gives fatality figures for the coal mines of the United States during the calendar years 1896 to 1914, inclusive. Table 2 gives comparative figures of the leading coal-producing countries with averages for a 10-year period. Table 3 classifies the deaths and injuries in and about the coal mines in the United States by causes; the year 1911 being chosen as a representative year. Falls of roof, slate, and coal cause the greatest number of fatal accidents and also the greatest number of serious injuries (those involving loss of 20 or more days of work), and slight injuries (those involving loss of less than 20 days' work). Mine cars and locomotives cause many accidents, especially serious and slight injuries, as shown. Table 4 gives similar data for all metal and miscellaneous mineral mines in the United States for the year 1914.

TABLE 1.—*Production, employees, and fatalities in coal mines of United States, 1896–1914.*[a]

| Year. | Total United States. | | | Portion of United States under inspection service. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total for States reporting accidents. | | | | Total killed. | | | | | Average tonnage per man.[d] | |
| | | | | Production. | | Employees. | | | | | | | | |
| | Production, short tons.[b] | Value per ton at mine. | Number employed.[b] | Short tons. | Percentage of total. | Number employed.[c] | Percentage of total.[c] | Total.[c] | Per 1,000 employed. | Per 1,000,000 tons mined. | Production per death, short tons.[c] | Days worked. | Per year. | Per day. |
| 1896 | 191,986,357 | 1.02 | 393,342 | 185,122,828 | 96.43 | 380,477 | 96.73 | 1,083 | 2.85 | 5.85 | 170,935 | 185 | 487 | 2.63 |
| 1897 | 200,229,199 | .99 | 397,701 | 194,731,837 | 97.25 | 388,585 | 97.71 | 990 | 2.55 | 5.08 | 196,699 | 179 | 501 | 2.80 |
| 1898 | 219,976,267 | .95 | 401,221 | 213,734,037 | 97.16 | 391,841 | 97.66 | 1,062 | 2.71 | 4.97 | 201,256 | 190 | 545 | 2.87 |
| 1899 | 253,741,192 | 1.01 | 410,635 | 243,993,172 | 96.16 | 395,607 | 96.34 | 1,241 | 3.14 | 5.08 | 196,610 | 214 | 617 | 2.88 |
| 1900 | 269,684,027 | 1.14 | 448,581 | 260,164,397 | 96.47 | 432,448 | 96.40 | 1,489 | 3.44 | 5.72 | 174,724 | 212 | 602 | 2.84 |
| 1901 | 293,299,816 | 1.19 | 485,544 | 291,449,047 | 99.37 | 480,807 | 99.02 | 1,574 | 3.27 | 5.40 | 185,165 | 216 | 606 | 2.81 |
| 1902 | 301,590,439 | 1.22 | 518,197 | 296,687,066 | 98.37 | 510,217 | 98.46 | 1,724 | 3.38 | 5.81 | 172,092 | 197 | 581 | 2.95 |
| 1903 | 357,356,416 | 1.41 | 566,260 | 352,064,631 | 98.52 | 556,581 | 98.29 | 1,926 | 3.46 | 5.47 | 182,796 | 220 | 633 | 2.88 |
| 1904 | 351,816,398 | 1.26 | 593,693 | 339,164,812 | 96.40 | 573,373 | 96.58 | 1,995 | 3.48 | 5.88 | 170,007 | 202 | 592 | 2.93 |
| 1905 | 392,722,635 | 1.21 | 626,045 | 386,379,243 | 98.38 | 615,368 | 98.29 | 2,232 | 3.63 | 5.78 | 173,109 | 212 | 628 | 2.96 |
| 1906 | 414,157,278 | 1.24 | 640,780 | 405,955,888 | 98.02 | 630,283 | 98.36 | 2,138 | 3.39 | 5.27 | 189,876 | 209 | 644 | 3.08 |
| 1907 | 480,363,424 | 1.28 | 680,492 | 477,892,536 | 99.49 | 674,613 | 99.14 | 3,242 | 4.81 | 6.78 | 147,407 | 231 | 708 | 3.06 |
| 1908 | 415,842,698 | 1.28 | 690,438 | 409,309,857 | 98.43 | 678,873 | 98.32 | 2,445 | 3.60 | 5.97 | 167,407 | 195 | 603 | 3.09 |
| 1909 | 469,814,616 | 1.20 | 666,552 | 460,807,263 | 99.99 | 666,535 | 99.99 | 2,642 | 3.96 | 5.73 | 174,416 | .... | 691 | .... |
| 1910 | 501,596,378 | 1.25 | 725,030 | 501,596,378 | 100.00 | 725,030 | 100.00 | 2,821 | 3.89 | 5.62 | 177,808 | 220 | 692 | 3.15 |
| 1911 | 496,371,126 | 1.26 | 728,348 | 496,371,126 | 100.00 | 728,348 | 100.00 | 2,656 | 3.65 | 5.35 | 186,887 | 220 | 682 | 3.10 |
| 1912 | 534,466,580 | 1.30 | 722,662 | 534,466,580 | 100.00 | 722,662 | 100.00 | 2,419 | 3.35 | 4.53 | 220,945 | 225 | 740 | 3.29 |
| 1913 | 570,048,125 | 1.33 | 747,644 | 570,048,125 | 100.00 | 747,644 | 100.00 | 2,785 | 3.73 | 4.89 | 204,685 | 238 | 762 | 3.20 |
| Total | 7,219,588,448 | .... | ..... | 7,133,464,300 | 98.44 | 11,062,477 | ..... | 38,918 | 3.45 | 5.47 | 184,320 | .... | 631 | .... |
| 1914 | 513,525,477 | 1.33 | 763,185 | 513,525,477 | 100.00 | 763,185 | 100.00 | 2,454 | 3.22 | 4.78 | 209,261 | 207 | 673 | 3.25 |

[a] Fay, A. H., Coal mine fatalities, Bull. 115, Bureau of Mines, 1915, p. 11.
[b] Mineral Resources, U. S. Geol. Survey.
[c] Summation based on State mine inspectors' reports.
[d] Number employed, selected from Mineral Resources, U. S. Geol. Survey.
[e] Calculated on basis of production represented by inspection States.
[f] Bureau of Census.
[g] Bureau of Mines.

TABLE 2.—*Comparison of accident statistics of leading coal-producing countries, with averages for 10 years, 1901–1910, inclusive.*[a]

| Country. | Average production (short tons) per year. | Average number employed per year. | Average number killed. | | | Average production per death (short tons). |
|---|---|---|---|---|---|---|
| | | | Per year. | Per 1,000 employed. | Per million short tons mined. | |
| United States | 389,269,000 | 607,438 | 2,270 | 3.74 | 5.83 | 172,000 |
| Great Britain | 274,794,000 | 890,434 | 1,210 | 1.36 | 4.40 | 227,000 |
| Germany | 134,785,000 | 482,132 | 1,017 | 2.11 | 7.55 | 133,000 |
| France | 38,785,000 | 178,749 | 302 | 1.69 | 7.79 | 128,000 |
| Belgium | 25,540,000 | 139,597 | 142 | 1.02 | 5.56 | 180,000 |
| Japan | 13,604,000 | 105,924 | 309 | 2.92 | 22.71 | 44,000 |
| India | 10,112,000 | 94,346 | 91 | 0.96 | 9.00 | 111,000 |
| Austria | 14,046,000 | 68,288 | 71 | 1.04 | 5.05 | 198,000 |
| New South Wales | 8,013,000 | 15,252 | 27 | 1.74 | 3.70 | 297,000 |

[a] Compiled from statistics published in Coal-Mine Accidents in the United States and Foreign Countries, by F. W. Horton, Bull. 69, Bureau of Mines, 1913.

TABLE 3.—*Deaths and injuries in and about the coal mines in the United States, 1911.*[a]

| Cause of accident. | Fatalities. | | Serious injuries.[b] | | Slight injuries.[c] | | Total deaths and injuries. |
|---|---|---|---|---|---|---|---|
| | Total. | Per cent. | Total. | Per cent. | Total. | Per cent. | |
| Falls of roof (coal, rock, etc.) | 1,173 | 43.14 | 3,052 | 33.52 | 6,259 | 28.16 | 10,484 |
| Falls of coal (other than roof coal) | 148 | 5.44 | 915 | 10.05 | 2,107 | 9.48 | 3,170 |
| Mine cars and locomotives | 393 | 14.45 | 2,179 | 23.93 | 5,570 | 25.06 | 8,142 |
| Gas explosions and burning gas | 99 | 3.64 | 365 | 4.01 | 329 | 1.48 | 793 |
| Coal-dust explosions[d] | 271 | 9.97 | 9 | 0.10 | 16 | 0.08 | 296 |
| "Blown-out or windy shots" | 9 | 0.33 | 43 | 0.47 | 54 | 0.25 | 106 |
| Explosives | 134 | 4.93 | 317 | 3.48 | 230 | 1.03 | 681 |
| Suffocation from mine gases | 8 | 0.29 | 7 | 0.08 | 24 | 0.11 | 39 |
| Electricity (shock or burns) | 87 | 3.20 | 63 | 0.69 | 212 | 0.95 | 362 |
| Animals | 7 | 0.26 | 206 | 2.26 | 854 | 3.84 | 1,067 |
| Mining machines | 13 | 0.48 | 245 | 2.69 | 645 | 2.90 | 903 |
| Machines other than locomotives and mining machines | 2 | 0.08 | 45 | 0.49 | 160 | 0.71 | 207 |
| Mine fires (burned, suffocated, etc.) | 80 | 2.94 | 6 | 0.07 | 22 | 0.10 | 108 |
| Other causes | 49 | 1.80 | 674 | 7.29 | 3,376 | 15.19 | 4,089 |
| Total underground accidents | 2,473 | 90.95 | 8,116 | 89.13 | 19,858 | 89.34 | 30,447 |
| Falling down shafts or slopes | 42 | 1.54 | 31 | 0.34 | 22 | 0.10 | 95 |
| Objects falling down shafts or slopes | 4 | 0.15 | 35 | 0.38 | 103 | 0.46 | 142 |
| Breaking of cables, chains, etc | 3 | 0.11 | 8 | 0.09 | 15 | 0.07 | 26 |
| Overwinding | 1 | 0.04 | 9 | 0.10 | 12 | 0.05 | 22 |
| Other causes | 13 | 0.48 | 34 | 0.37 | 62 | 0.28 | 109 |
| Total shaft accidents | 63 | 2.32 | 117 | 1.28 | 214 | 0.96 | 394 |
| Mine cars and mine locomotives | 45 | 1.65 | 274 | 3.01 | 534 | 2.40 | 853 |
| Electricity (shock or burns) | 7 | 0.26 | 9 | 0.10 | 35 | 0.16 | 51 |
| Machinery | 33 | 1.21 | 192 | 2.11 | 430 | 1.93 | 655 |
| Boiler explosions | 3 | 0.11 | 10 | 0.11 | 13 | 0.06 | 26 |
| Railway cars and locomotives | 32 | 1.18 | 92 | 1.01 | 215 | 0.97 | 339 |
| Other causes | 63 | 2.32 | 296 | 3.25 | 929 | 4.18 | 1,288 |
| Total surface accidents | 183 | 6.73 | 873 | 9.59 | 2,156 | 9.70 | 3,212 |
| Grand total | 2,719 | 100.00 | 9,106 | 100.00 | 22,228 | 100.00 | 34,053 |

[a] Compiled from statistics in Coal-Mine Accidents in the United States and Foreign Countries, by F. W. Horton, Bull. 69, Bureau of Mines, 1913.
[b] Involving loss of 20 or more days' work.
[c] Loss of less than 20 days' work.
[d] These dust explosions may have been started by powder or gas explosions or other initiating causes.

TABLE 4.—*Number of men killed and injured in and about all metal and miscel calendar year*

NUMBER KILLED.

| Kind of mine. | Killed underground. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fall of rock or ore from roof or wall. | Rock or ore while loading at working face. | Timber or hand tools. | Explosives. | Haulage accidents. | Falling down chute, winze, raise, or stope. | Run of ore from chute or pocket. | Drilling accidents. | Electricity. | Machinery (not including locomotives or drills). |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Copper | 57 | 2 | 1 | 14 | 10 | 22 | 4 | 1 | 5 | ..... |
| Gold and miscellaneous metal | 52 | 1 | ..... | 22 | 6 | 21 | 1 | 2 | 3 | ..... |
| Iron | 51 | 3 | 1 | 8 | 13 | 5 | ..... | ..... | ..... | ..... |
| Lead and zinc (Mississippi Valley) | 20 | 1 | 1 | 4 | ..... | ..... | ..... | ..... | ..... | 1 |
| Miscellaneous mineral | 5 | ..... | ..... | 1 | 2 | ..... | ..... | ..... | ..... | ..... |
| **Total** | **185** | **7** | **3** | **49** | **31** | **48** | **5** | **3** | **8** | **1** |
| Percentage of grand total killed | 33.09 | 1.25 | .54 | 8.76 | 5.55 | 8.59 | .89 | .54 | 1.43 | .18 |
| Percentage of class total killed | 50.55 | 1.91 | .82 | 13.39 | 8.47 | 13.11 | 1.37 | .82 | 2.19 | .27 |
| Number killed per 1,000 employed underground [b] | 1.82 | .07 | .03 | .48 | .30 | .47 | .05 | .03 | .08 | .01 |

NUMBER SERIOUSLY INJURED.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Copper | 486 | 269 | 142 | 41 | 262 | 81 | 36 | 65 | 1 | 9 |
| Gold and miscellaneous metal | 259 | 45 | 62 | 37 | 106 | 49 | 15 | 47 | ..... | 19 |
| Iron | 313 | 115 | 209 | 42 | 267 | 56 | 42 | 53 | 3 | 11 |
| Lead and zinc (Mississippi Valley) | 51 | 4 | 3 | 6 | 19 | 4 | ..... | 3 | ..... | 4 |
| Miscellaneous mineral | 9 | 9 | 5 | 4 | 15 | 1 | ..... | 7 | 1 | 2 |
| **Total** | **1,118** | **442** | **421** | **130** | **669** | **191** | **93** | **175** | **5** | **45** |
| Percentage of grand total seriously injured | 22.04 | 8.71 | 8.30 | 2.56 | 13.19 | 3.76 | 1.83 | 3.45 | .10 | .89 |
| Percentage of class total seriously injured | 29.69 | 11.74 | 11.18 | 3.45 | 17.76 | 5.07 | 2.47 | 4.65 | .13 | 1.19 |
| Number seriously injured per 1,000 employed underground [b] | 11.00 | 4.35 | 4.14 | 1.28 | 6.58 | 1.88 | .92 | 1.72 | .05 | .44 |

NUMBER SLIGHTLY INJURED.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Copper | 2,529 | 1,634 | 961 | 84 | 1,081 | 353 | 282 | 515 | 20 | 51 |
| Gold and miscellaneous metal | 966 | 427 | 466 | 35 | 503 | 174 | 131 | 369 | 4 | 45 |
| Iron | 1,219 | 762 | 793 | 43 | 843 | 86 | 137 | 320 | 17 | 42 |
| Lead and zinc (Mississippi Valley) | 252 | 235 | 69 | 38 | 174 | 16 | 6 | 87 | 3 | 18 |
| Miscellaneous mineral | 20 | 53 | 20 | 4 | 33 | 3 | ..... | 22 | 3 | 3 |
| **Total** | **4,986** | **3,111** | **2,309** | **204** | **2,634** | **632** | **556** | **1,313** | **47** | **159** |
| Percentage of grand total slightly injured | 19.83 | 12.37 | 9.18 | .81 | 10.48 | 2.51 | 2.21 | 5.22 | .19 | .63 |
| Percentage of class total slightly injured | 25.53 | 15.93 | 11.82 | 1.04 | 13.49 | 3.24 | 2.85 | 6.72 | .24 | .81 |
| Number slightly injured per 1,000 employed underground [b] | 49.07 | 30.62 | 22.72 | 2.01 | 25.92 | 6.22 | 5.47 | 12.92 | .46 | 1.56 |

[a] Fay, A. H., Metal-mine accidents in the United States during the calendar year 1914, Tech. Paper 129, Bureau of Mines, 1916, pp. 14–17.

[b] Casualty rate per 1,000 employed is based on underground employees for underground accidents, and on surface employees for surface accidents.

*laneous mineral mines (except coal mines) in the United States during the 1914, by causes.*[a]

NUMBER KILLED.

| Killed underground—Continued. | | | | | | Killed in shaft. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mine fires. | Suffocation from natural gases. | Inrush of water. | Stepping on nail. | Other causes. | **Total, underground.** | Falling down shafts. | Objects falling down shafts. | Breaking of cables. | Overwinding. | Skip or cage. | Other causes. | **Total, shaft.** |
| 11 | 12 | 13 | 14 | 15 | | 16 | 17 | 18 | 19 | 20 | 21 | |
| 2 | | | | 1 | **119** | 8 | 2 | | | 15 | 3 | **28** |
| 4 | 1 | | | 3 | **116** | 13 | 2 | 2 | | 19 | 2 | **38** |
| 2 | | 8 | | 2 | **93** | 10 | 4 | | | 7 | 6 | **27** |
| 2 | | | | 1 | **30** | 3 | 2 | | | 2 | | **7** |
| | | | | | **8** | | | | | | | |
| **10** | **1** | **8** | | **7** | **366** | **34** | **10** | **2** | | **43** | **11** | **100** |
| 1.79 | .18 | 1.43 | | 1.25 | **65.47** | 6.08 | 1.79 | .36 | | 7.70 | 1.96 | **17.89** |
| 2.73 | .27 | 2.19 | | 1.91 | **100.00** | 34.00 | 10.00 | 2.00 | | 43.00 | 11.00 | **100.00** |
| .10 | .01 | .08 | | .07 | **3.60** | .33 | .10 | .02 | | .42 | .11 | **.98** |

NUMBER SERIOUSLY INJURED.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 4 | 226 | **1,622** | 8 | 12 | | | 30 | 24 | **74** |
| 4 | | | 2 | 74 | **719** | 6 | 6 | 3 | | 18 | 11 | **44** |
| | 3 | | 6 | 145 | **1,265** | 8 | 9 | | 1 | 24 | 13 | **55** |
| | | | | 12 | **106** | 3 | 3 | | | 4 | 2 | **12** |
| | | | | 1 | **54** | | | | | | | |
| **4** | **3** | | **12** | **458** | **3,766** | **25** | **30** | **3** | **1** | **76** | **50** | **185** |
| .08 | .06 | | .23 | 9.03 | **74.23** | .49 | .59 | .06 | .02 | 1.50 | .99 | **3.65** |
| .11 | .08 | | .32 | 12.16 | **100.00** | 13.51 | 16.22 | 1.62 | .54 | 41.08 | 27.03 | **100.00** |
| .04 | .03 | | .12 | 4.51 | **37.06** | .24 | .30 | .03 | .01 | .75 | .49 | **1.82** |

NUMBER SLIGHTLY INJURED.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | | 104 | 1,553 | **9,171** | 8 | 59 | | | 60 | 45 | **172** |
| 1 | 11 | | 34 | 630 | **3,796** | 9 | 33 | 6 | 1 | 25 | 23 | **97** |
| | 5 | 12 | 74 | 756 | **5,109** | 4 | 39 | | 1 | 62 | 50 | **156** |
| | | | 8 | 363 | **1,269** | 4 | 21 | | | 35 | 28 | **88** |
| | | | 2 | 23 | **186** | | | | | 2 | | **2** |
| **2** | **19** | **12** | **222** | **3,325** | **19,531** | **25** | **152** | **6** | **2** | **184** | **146** | **515** |
| .01 | .08 | .05 | .88 | 13.23 | **77.68** | .10 | .61 | .02 | .01 | .73 | .58 | **2.05** |
| .01 | .10 | .06 | 1.14 | 17.02 | **100.00** | 4.85 | 29.51 | 1.17 | .39 | 35.73 | 28.35 | **100.00** |
| .02 | .19 | .12 | 2.18 | 32.72 | **192.20** | .25 | 1.49 | .06 | .02 | 1.81 | 1.44 | **5.07** |

TABLE 4.—*Number of men killed and injured in and about all metal and miscel calendar year 191[illegible].*

NUMBER KILLED.

| Kind of mine. | Surface (shops and power plants). | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mine cars, mine locomotives, or aerial trams. | Railway cars and locomotives. | Run or fall of ore in or from ore bins. | Falls of persons. | Stepping on nail. | Hand tools, axes, bars, etc. | Electricity. | Machinery. | Other causes. | Total, surface. |
| | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | |
| Copper | 2 | 2 | | 1 | | | | | 3 | 8 |
| Gold and miscellaneous metal | | 2 | 2 | | | | 3 | 2 | 2 | 11 |
| Iron | 1 | 1 | 2 | 3 | | | 1 | 1 | 2 | 11 |
| Lead and zinc (Mississippi Valley) | | | | | | | | 1 | 1 | 2 |
| Miscellaneous mineral | | 2 | 1 | | | | 2 | | | 5 |
| **Total** | **3** | **7** | **5** | **4** | | | **6** | **4** | **8** | **37** |
| Percentage of grand total killed | .54 | 1.25 | .89 | .72 | | | 1.07 | .72 | 1.43 | 6.62 |
| Percentage of class total killed | 8.11 | 18.92 | 13.51 | 10.81 | | | 16.21 | 10.81 | 21.62 | 100.00 |
| Number killed per 1,000 employed on the surface | .05 | .12 | .09 | .07 | | | .11 | .07 | .14 | .65 |

NUMBER SERIOUSLY INJURED.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Copper | 21 | 4 | 10 | 32 | 4 | 44 | 2 | 34 | 70 | 224 |
| Gold and miscellaneous metal | 10 | 2 | 3 | 10 | | 13 | 1 | 26 | 24 | 89 |
| Iron | 30 | 10 | 4 | 60 | 3 | 29 | | 38 | 72 | 246 |
| Lead and zinc (Mississippi Valley) | 2 | 1 | 2 | 4 | 1 | 5 | | 6 | 7 | 28 |
| Miscellaneous mineral | | 1 | 2 | 5 | | 1 | | 3 | 8 | 20 |
| **Total** | **66** | **18** | **21** | **111** | **8** | **92** | **3** | **107** | **181** | **607** |
| Percentage of grand total seriously injured | 1.30 | .36 | .41 | 2.19 | .16 | 1.81 | .06 | 2.11 | 3.57 | 11.97 |
| Percentage of class total seriously injured | 10.87 | 2.96 | 3.46 | 18.29 | 1.32 | 15.16 | .49 | 17.63 | 29.82 | 100.00 |
| Number seriously injured per 1,000 employed on the surface[a] | 1.17 | .32 | .37 | 1.97 | .14 | 1.63 | .05 | 1.89 | 3.20 | 10.74 |

NUMBER SLIGHTLY INJURED.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Copper | 81 | 18 | 30 | 68 | 38 | 144 | 8 | 73 | 302 | 762 |
| Gold and miscellaneous metal | 35 | 26 | 11 | 39 | 19 | 80 | 5 | 45 | 181 | 441 |
| Iron | 54 | 20 | 18 | 136 | 52 | 156 | 7 | 76 | 365 | 884 |
| Lead and zinc (Mississippi Valley) | 12 | 6 | 9 | 12 | 14 | 34 | 2 | 18 | 139 | 246 |
| Miscellaneous mineral | 9 | 5 | 6 | 21 | 14 | 20 | 1 | 14 | 86 | 176 |
| **Total** | **191** | **75** | **74** | **276** | **137** | **434** | **23** | **226** | **1,073** | **2,509** |
| Percentage of grand total slightly injured | .76 | .30 | .29 | 1.10 | .54 | 1.73 | .09 | .90 | 4.27 | 9.98 |
| Percentage of class total slightly injured | 7.61 | 2.99 | 2.95 | 11.00 | 5.46 | 17.30 | .92 | 9.01 | 42.76 | 100.00 |
| Number slightly injured per 1,000 employed on the surface[a] | 3.38 | 1.33 | 1.31 | 4.89 | 2.42 | 7.68 | .41 | 4.00 | 18.99 | 44.41 |

[a] Casualty rates per 1,000 employed is based on underground employees for underground accidents and on surface employees for surface accidents.

*laneous mineral mines (except coal mines) in the United States during the by causes*—Continued.

NUMBER KILLED.

| Open pit. | | | | | | | | | | | | Grand total. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Falls or slides of rock or ore. | Explosives. | Haulage accidents (locomotives, etc.). | Steam shovels. | Falls of persons. | Falls of derricks, booms, etc. | Run or fall of ore in or from ore bins. | Machinery (other than locomotives or steam shovels). | Electricity. | Hand tools. | Other causes. | Total, open pit. | | | | |
| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | | 1914 | 1913 | 1912 | 1911 |
| 1 | 6 | 3 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 10 | 165 | 236 | 239 | 238 |
| 3 | 3 | 1 | ..... | 2 | 1 | ..... | 1 | 2 | ..... | 1 | 14 | 179 | 210 | 176 | 193 |
| 7 | 2 | 5 | 1 | 1 | ..... | ..... | 1 | ..... | ..... | ..... | 17 | 148 | 165 | 172 | 197 |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1 | 1 | 40 | 42 | 54 | 43 |
| 7 | ..... | ..... | ..... | 1 | ..... | ..... | 3 | 1 | ..... | 2 | 14 | 27 | 30 | 20 | 24 |
| **18** | **11** | **9** | **1** | **4** | **1** | ..... | **5** | **3** | ..... | **4** | **56** | **559** | **683** | **661** | **695** |
| 3.22 | 1.96 | 1.61 | .18 | .72 | .18 | ..... | .89 | .54 | ..... | .72 | 10.02 | **100.00** | ..... | ..... | ..... |
| 32.14 | 19.64 | 16.07 | 1.79 | 7.14 | 1.79 | ..... | 8.93 | 5.36 | ..... | 7.14 | 100.00 | ..... | ..... | ..... | ..... |
| .32 | .19 | .16 | .02 | .07 | .02 | ..... | .09 | .05 | ..... | .07 | .99 | **3.54** | 3.57 | 3.91 | 4.19 |

NUMBER SERIOUSLY INJURED.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | 17 | 25 | 5 | 6 | 1 | ..... | 10 | 2 | 4 | 26 | 117 | **2,037** | 2,195 | 1,807 | 1,326 |
| 2 | 4 | 1 | ..... | 10 | ..... | ..... | 19 | ..... | 9 | 14 | 59 | **911** | 632 | 613 | 540 |
| 52 | 17 | 43 | 27 | 24 | 4 | ..... | 6 | ..... | 25 | 87 | 285 | **1,851** | 2,820 | 1,800 | 2,032 |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | **146** | 91 | 147 | 177 |
| 13 | ..... | 9 | ..... | 3 | 3 | ..... | 9 | ..... | 6 | 11 | 54 | **128** | 152 | 135 | 94 |
| **88** | **38** | **78** | **32** | **43** | **8** | ..... | **44** | **2** | **44** | **138** | **515** | **5,073** | **5,890** | **4,502** | **4,169** |
| 1.73 | .75 | 1.53 | .63 | .85 | .16 | ..... | .86 | .04 | .86 | 2.74 | 10.15 | **100.00** | ..... | ..... | ..... |
| 17.09 | 7.38 | 15.15 | 6.21 | 8.35 | 1.55 | ..... | 8.54 | .39 | 8.54 | 26.80 | 100.00 | ..... | ..... | ..... | ..... |
| 1.56 | .67 | 1.38 | .57 | .76 | .14 | ..... | .78 | .04 | .78 | 2.44 | 9.12 | **32.08** | 30.79 | 26.61 | 25.12 |

NUMBER SLIGHTLY INJURED.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 282 | 67 | 137 | 47 | 140 | ..... | 1 | 50 | 2 | 88 | 411 | 1,225 | **11,330** | 11,168 | 11,830 | 9,016 |
| 43 | 1 | 6 | ..... | 22 | ..... | 5 | 78 | 3 | 111 | 87 | 356 | **4,690** | 3,223 | 3,180 | 3,078 |
| 91 | 18 | 83 | 73 | 77 | 5 | ..... | 13 | ..... | 115 | 298 | 773 | **6,922** | 10,653 | 8,707 | 8,690 |
| 1 | ..... | ..... | ..... | 1 | ..... | ..... | ..... | ..... | ..... | ..... | 2 | **1,605** | 1,345 | 1,849 | 1,311 |
| 36 | 6 | 25 | 1 | 15 | 1 | 2 | 23 | 1 | 32 | 90 | 232 | **596** | 692 | 666 | 313 |
| **453** | **92** | **251** | **121** | **255** | **6** | **8** | **164** | **6** | **346** | **886** | **2.588** | **25,143** | **27,081** | **26.232** | **22.408** |
| 1.80 | .37 | 1.00 | .48 | 1.02 | .02 | .03 | .65 | .02 | 1.38 | 3.52 | 10.29 | **100.00** | ..... | ..... | ..... |
| 17.50 | 3.55 | 9.70 | 4.68 | 9.85 | .23 | .31 | 6.34 | .23 | 13.37 | 34.24 | 100.00 | ..... | ..... | ..... | ..... |
| 8.02 | 1.63 | 4.44 | 2.14 | 4.51 | .11 | .14 | 2.90 | .11 | 6.13 | 15.68 | 45.81 | **159.02** | 141.58 | 155.04 | 135.01 |

## SAFETY DEPARTMENT.

An organization imbued with the value and importance of preventing accidents must get its inspiration from the president or owner. This must be passed down with undiminished vigor through the general manager, superintendent, foreman, and subordinates. The never-flagging interest of these officials in the safety of their workmen must be expressed and reiterated through the medium of rigid inspection, the installation of safety appliances, safety committees, the posting of notices and warnings, promotion of first aid and rescue training, provision for care of injured, and such educational means as lectures, rallies, and miners' field meets.

Of interest in this connection is the following announcement taken from the first issue of the Anode, a bulletin published monthly by the Anaconda Copper Mining Co. in the interest of safety work:

### ANNOUNCEMENT.

The Anaconda Copper Mining Co. expects all superintendents and foremen to make every effort to prevent injury to employees. All practices which are likely to be the cause of an accident must be stopped. Much good can be accomplished by designing new construction and machinery with all practical safeguards, and you should take steps to see that this is done. Help to make and keep the mines and plants safe.

Expenditures necessary for such purposes will be authorized. Nothing which will add to the protection of the workmen should be neglected. The safety and welfare of the workmen is of the greatest concern.

Organization of safety work naturally differs somewhat in the various mining fields, largely in consequence of local conditions, whether the mines are coal or metal, and the number of men employed. With certain changes to suit large or small operations the following scheme has proved successful and should serve as a basis for new organizations:

### SAFETY INSPECTOR.

A large company operating several mines should have a safety department, in charge of a safety inspector or a safety engineer, depending upon the number of mines and the extent of the operations. His services should be devoted solely to safety work, independent of the operating department, and he should report directly to the executive. A person charged with and responsible to the executive for the adoption and enforcement of safety measures is far more effective in producing results than any committee.

The department chief may have one or more assistant inspectors for carrying on the work according to the extent of the territory and the number of operations under his supervision. Regular and careful inspections of all equipment and of conditions in every mine

are made and proper safety measures are introduced. The inspector should receive the cooperation and active support of superintendents and foremen in furthering such work.

In smaller operations the safety work must necessarily be more closely associated with the operating department, in which event the inspector may perform duties other than those connected with mine inspection.

The mine rescue and first-aid department usually comes under the supervision of the inspector. In some instances the inspector is called upon to assist in the welfare and educational work and to encourage, with the view of improving health conditions, better standards of living among the employees.

### SAFETY COMMITTEES.

Some or all of the following committees should be maintained according to the size and number of the various operations controlled by each company:

1. A central safety committee, composed of the general manager, general superintendent, chief engineer, inspector, secretary, or other officials, which should hold monthly meetings. Reports and recommendations of the inspector and of subcommittees should be received and if practical put into effect, the causes of accidents studied and classified, and steps taken to avoid the recurrence of similar accidents. Regular trips of inspection should be made and greater impetus given the movement by frequent public meetings in the interest of safety. Due publicity will thereby be given in addition to the constant evidence afforded by the work as it progresses.

2. A plant safety committee composed of the superintendent, assistant superintendent, mine foremen, captains,[a] firebosses, electrical engineer, mechanical engineer, mining engineer, and chief clerk. In the smaller operations this committee might be substituted for the central safety committee and perform the functions outlined above; in this event the inspector would be a member ex officio. Reports should be submitted to the executive head, usually the general superintendent. The members of this committee would be the active agents in carrying out the provisions of the law and such measures as may be adopted for promoting safety. This committee should hold regular monthly meetings for the consideration and discussion of all safety problems and submit monthly a detailed written report stating the progress made, with recommendations. These reports would give the judgment and recommendations of men who have had the most intimate experience with all the various divisions of underground work and would tend to standardize underground practice as a whole. It is extremely important that the foremen be-

[a] Metal-mining term for underground foreman.

come actively interested, as it is the foremen who must enforce the rules finally adopted, and service in the committee best acquaints them with the reasons for these rules.

3. At each mine a mine safety committee should be organized, consisting of men doing different kinds of work and usually of different nationalities. This committee would make regular monthly inspections and submit written reports, with recommendations, directly to the central safety committee or the executive. The committee should consist of three members appointed by the superintendent or the foreman or elected by the miners as conditions may indicate will prove most satisfactory and effective. Each member should serve two to four months and be succeeded by a new member, so that in time a large number of men of various nationalities would have been in a position where they would feel individual responsibility and could more readily understand the need of cooperation. All members of this committee should be furnished with a safety button specially designed for each company, the ex-members retaining theirs in honorary membership. Inspection trips of such workmen's committees tend greatly to interest the men. Better cooperation is insured and habits of indifference and carelessness are discouraged. For all time spent in this work, the members of the committee should receive their regular pay. Mixed committees of workmen and foremen and other officials have been appointed at some mines. Such committees, acting as plant committees, have the advantage of bringing the management and men together in work for greater safety, and induce a comparison of viewpoints.

### SPECIAL INSPECTION.

In addition to the inspection provided by law some companies have established special systems of inspection by dividing the mines into separate sections, each embracing 25 to 40 men and being under the direct supervision of an assistant foreman or safety boss, who must visit and inspect during the day at two to three hour intervals all working places, give instructions, and see personally that his orders are understood and carried out. As the greatest number of injuries and fatalities happen in working places and are caused by falls of roof, ore, or coal, such a system commends itself as a practical means of getting results.

### SAFETY DEPARTMENT FOR SMALL MINES.

At small mines employing 50 to 100 men, or even in some of the larger mines where the employment of a special safety inspector is not warranted, safety organization can probably be advanced best through a safety department formed by the local management. This

work to be successful must have the active sympathy and support of one of the higher officials of the company, preferably the one acting as a safety inspector. The mine superintendent might have immediate direction of the safety work and be empowered to adopt any desired safety measures for any particular mine.

A plant committee composed of the superintendent, foreman, and assistants, and a mine safety committee composed of three representative workmen could proceed along the same lines as outlined for larger mines and with greater thoroughness. Such committee work does not in any way replace the more valuable supervision and careful and frequent daily underground inspections by foremen and assistants, but supplements them and stimulates interest in safety. Safety is a personal matter, and the personal contact of officials and men in small mines is an advantage that should result in a rapid response to the safety idea. Educational work can be promoted in its entirety and safety measures adopted on a scale affecting the greatest number of workmen.

A group of small mines separately owned may advantageously cooperate in a joint safety organization, perhaps associated with a central rescue station.

### FEATURES OF THE WORK.

Many of the following desirable results have been the direct outcome of safety work:

Enthusiasm for safety work;
Excellent discipline;
Systematization of rules and regulations;
Rules printed in various languages for the benefit of all employees;
Systematic posting of danger signs and signboards;
Uniformity in signals;
Regular and frequent inspections;
Unsafe conditions promptly reported and remedied.
Dangerous machinery safeguarded;
Careful investigation of all accidents with detailed reports on how to avoid another similar accident;
Frequent public meetings in the interest of safety;
Maintenance of suggestion boxes and bulletin boards;
Increased use of fireproof material in construction;
Provision for emergencies in case of accidents, explosions, and fires, with necessary equipment and well-trained teams in first aid, mine rescue, and fire fighting;
Frequent inspection of emergency equipment;
Promotion of sanitation and welfare work;
Promotion of general educational work.

Such work cultivates the necessary spirit of enthusiasm and cooperation. The inspection trips acquaint all workmen with the endeavors toward safety; the work is advertised, and every man

knows that special effort is being made to reduce accidents. Workmen who serve on committees have a feeling of individual responsibility and consider membership an honor. At many mines printed bulletins dealing entirely with safety matters are issued periodically. Interest is further stimulated by the award of banners and prizes to divisions having the best records in accident prevention.

### COOPERATION.

Although it appears that much recklessness exists among industrial workers, every man has an inherent desire to save life, whether it be his own or that of another. Because of the hazards of mining, there is a natural fellowship among miners which has often been evidenced by heroic acts done without desire for reward. Will not men who risk their lives to save those of their fellows be equally willing to make a mine safer? This question can undoubtedly be answered in the affirmative when the men fully realize how much they can do to prevent accidents. Every working day in the coal mines of our country 50 men are either killed or severely injured and approximately 100 more receive less serious injuries. In the metal mines 20 men are either killed or severely injured daily, and the number of those less seriously injured approximates the number in coal mining, although the total number employed is less than one-fourth of that employed in coal mining. Every miner who has had such facts brought to his notice may be expected to give his hearty cooperation to a work that so vitally concerns him.

Mine operators realize that it is to their advantage to promote safety. The decrease of fatalities and injuries is always accompanied by an economic gain. Every accident impairs the working efficiency of an organization, causes delay, curtails production.

Individual effort toward accident prevention is being recognized and rewarded. Foremen are such essential factors in accident prevention that there is a growing tendency to select as foremen those men who are most careful to avoid accidents.

### BONUS SYSTEMS.

One promising innovation of the safety movement is the bonus system now used by many companies. Under this system foremen and assistant foremen receive a cash bonus each month for good records in preventing accidents during any one working month, and an additional bonus for a record entirely free for a period of six months or more. Demerits incurred through accidents in any one month can be worked off in subsequent months. One large company has maintained a bonus system for four and one-half years at a cost of 0.15 cent per ton of coal produced. Score boards of various kinds are maintained for comparisons of months, years, or depart-

ments. Such a system naturally creates a desire among the foremen to cooperate with the management in promoting safety work.

The necessary interest and cooperation of the workmen can be secured only when the company shows an attitude of absolute frankness in dealing with the matter. Companies that have had the longest experience in safety work emphasize the necessity of securing the confidence of employees so that the latter may see and perform their part in achieving the desired end.

## EDUCATION OF MINERS.

Education is the foundation rock in accident prevention. Education and inspection can, it is believed, eliminate the majority of the preventable accidents. The word education as here used does not imply such training as will make engineers, foremen, or mine managers, but simply the direct training of the average miner so that he may know clearly how to do his daily work with greater personal safety. The following pages deal with the most widely adopted means for promoting the safety movement through education.

### PERSONAL INSTRUCTION IN SAFE PRACTICES.

Although it is true that many experienced miners meet serious injury, this is due largely to the fact that such miners are granted many more privileges than the inexperienced man, do all the most dangerous mining, and have probably grown unresponsive to thoughts of personal safety through daily contact with danger. It is natural to expect that conditions favor the experienced and thoughtful miner, and it is an established fact that the careful worker is as a rule the most efficient.

The number of miners, motormen, drivers, and trip riders or brakemen, who meet accidents caused by carelessness emphasizes the necessity of pointing out the reckless and dangerous practices that are often contracted. Training and education are necessary for safety and efficiency, and therefore all classes and types of labor should be interested in accident prevention.

Especially should all new workmen receive instruction in a language they understand, as to proper and safe methods of work. It is particularly important that they be warned of dangers apparent only to intelligent and experienced workmen and be shown how to avoid such dangers. Practical instruction at the working face supplemented by illustrated classroom talks should be given on how and when to set timber, precaution in testing the roof or back, use of safety lamps and portable electric lamps, handling explosives, blocking cars in rooms, and underground traveling to and from

work. Experience is a good teacher, but the risk involved in permitting the inexperienced miner to pursue his own methods is too great. A miner should possess knowledge that will enable him to work in comparative safety when left to his own resources. Such instruction makes both an efficient workman and a useful citizen out of a new recruit, and is greatly promoted by an adequate inspection system that gives personal directions whenever and wherever required.

### INSTRUCTION IN ENGLISH.

The Roberts system of instruction in English has greatly simplified the problem that confronts all industries that employ non-English-speaking labor. The need of an instruction system has been pointed out by Roberts[a] as follows:

> Sixty-two per cent of the men employed in the bituminous coal industry are foreign born. A larger percentage is found in the anthracite coal industry. These men represent more than 26 nationalities. * * * The question we must face is, What is the relation of the existing variety of languages among employees to the loss of life and property in this hazardous industry?
>
> Our record of fatal and nonfatal injuries will not compare with that of Great Britain or Germany, and one of the prime causes for this is the fact that in the United States employers have heterogeneous groups to deal with, whereas in Europe the men digging coal are more homogeneous. Every mining plant is a unit, and the men who fructify the capital put into it make an organization which must be harmonious in order that the greatest degree of security to life, limb, and property may be attained. This result can only be secured by every member of the organization being able to communicate with every other member, or in other words the organization ought to have a common medium of communication to get the best results. * * *
>
> Therefore the only practical solution is for every foreign-speaking man in the mine to learn to talk English, so that he can communicate with the boss and the boss communicate with him, or the men communicate with one another. This can be done. Given a practical system, intelligent, capable, and sympathetic teachers, the cooperation of the employers, and the indorsement of the employees, and in a year every man in a mine would have such a knowledge of the English language as to understand simple instructions, and in cases of emergency be able to talk to his fellow workman, so as to secure cooperative action which might mean the saving of life, limb, and property.

Figures 7 and 8 show sample pages of the Delaware, Lackawanna & Western Railroad Co. handbook on safe and unsafe methods of work explained by the Roberts system. Any desired lessons on mine safety and mine regulations can be taught in like manner.

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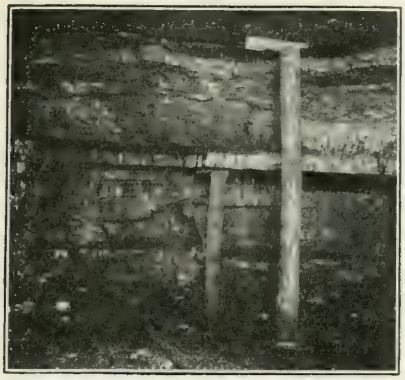
[a] Roberts, Peter, secretary, industrial department, the international committee, of Young Men's Christian Association, Personal communication.



Two props standing and miner lighting squib.

Props are knocked out by shot.

Miner hurt by fall of rock.

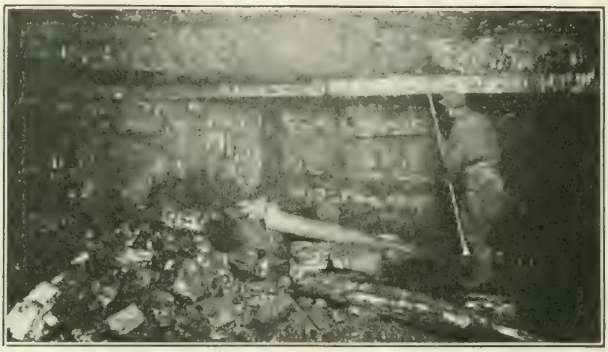
**PROPS KNOCKED OUT BY A SHOT.**

| | |
|---|---|
| see | We see two props in this chamber. |
| hold up | The props hold up the top. |
| tamped | The hole has been tamped. |
| lights | The miner lights the squip. |
| shouts | The miner shouts "Fire! Fire!" |
| runs back | He runs back to the crosscut. |
| goes off | The shot goes off. |
| returns | The miner returns to the face. |
| blown out | He finds the props are blown out. |
| examine | HE DOES NOT EXAMINE THE TOP. |
| goes into | HE GOES INTO THE FACE. |
| falls | THE TOP FALLS ON HIM. |
| injured | HE IS INJURED. |

What is the miner in the picture doing? Where does he go? What happens to the props? Did he examine the top? Is this a careful miner?

**Don't fail to examine the top after every shot.**

FIGURE 7.—Sample page of handbook, illustrating unsafe practice in firing shots.



Miner examines roof after shot.

Miner and laborer replacing props.

**REPLACING PROPS AFTER A SHOT.**

| | |
|---|---|
| has returned | The miner has returned to the face. |
| are down | He finds the props are down. |
| examines | He examines the roof with his drill. |
| finds | He finds the top is bad. |
| must make | The miner must make the top safe. |
| calls | He calls his laborer. |
| put back | The miner and laborer put the props back in place. |
| is safe | The chamber is now safe. |
| can load | Now the laborer can load his coal. |
| | This is a careful miner. |

What is the miner doing in this picture? What does he do with the bad top? Is it safe to work under bad top? Should the laborer begin to load coal before he knows the top is safe?

**Always examine the top after a shot.**

FIGURE 8.—Sample page of handbook, illustrating safe practice.

Figures 9 and 10 show parts of pages from the H. C. Frick Coke Co. "Safety-First" book.

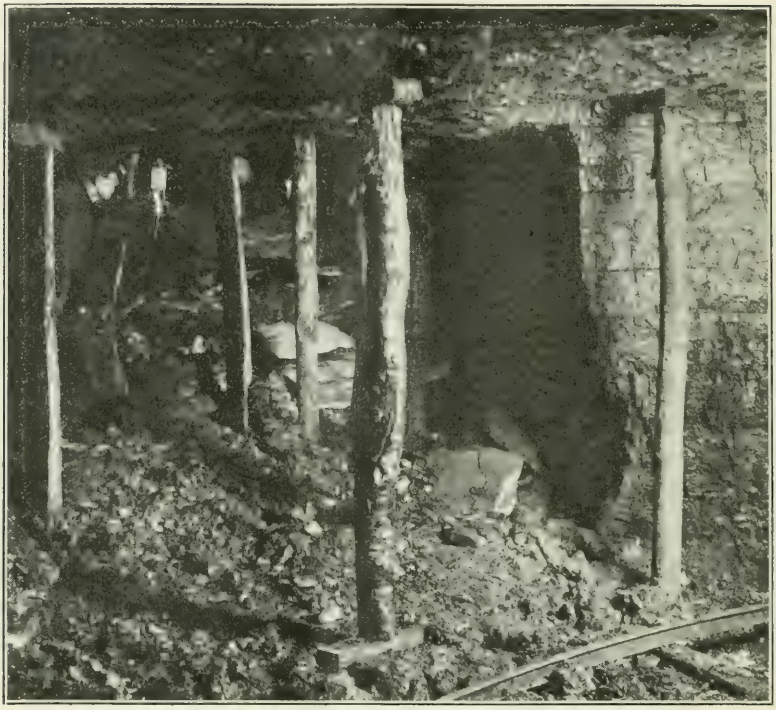
**Searching men for matches and pipes.**

This mine gives off explosive gas. The men use safety lamps only. Open lights can not be used. **Miners must not take matches or pipes in such mines. The law says they must not. It would not be safe for anybody if they did.** The men have just come down the shaft. They are going in to work. They have their safety lamps and buckets. One man is "trying" their safety lamps. Another is feeling in their pockets. If the safety lamps are not all right, they will be sent back to the lamp house. If they have pipes or matches, they will be found. The mine inspector will get their names. He will have such persons arrested.

**Do not take pipes nor matches in the mine.**

**If your lamp is not all right, tell the boss.**

FIGURE 9.—Part of page from safety-first book, illustrating method of teaching men not to carry matches into the mine.



**Fire boss looking for explosive gas.**

Safety lamps only are used in this mine. This is the edge of a gob. The fire boss is up on the "fall" trying for gas. He will mark the date on the rock upon the fall. He will also mark the date on the face of your place, and on another place, which may be the side, a post, or a shovel. The first thing you should do is to look for this mark. If you do not find it, go tell the boss right away.

**Before you begin work look for the fire boss' mark.**

FIGURE 10.—Part of a page from safety-first book, instructing men in dangers from gas.

Figures 11 and 12, taken from Miners' Circular 17,[a] show unsafe practice in metal mining.

FIGURE 11.—Miner working under loose back. Don't work under loose ground or ground that looks unsafe.

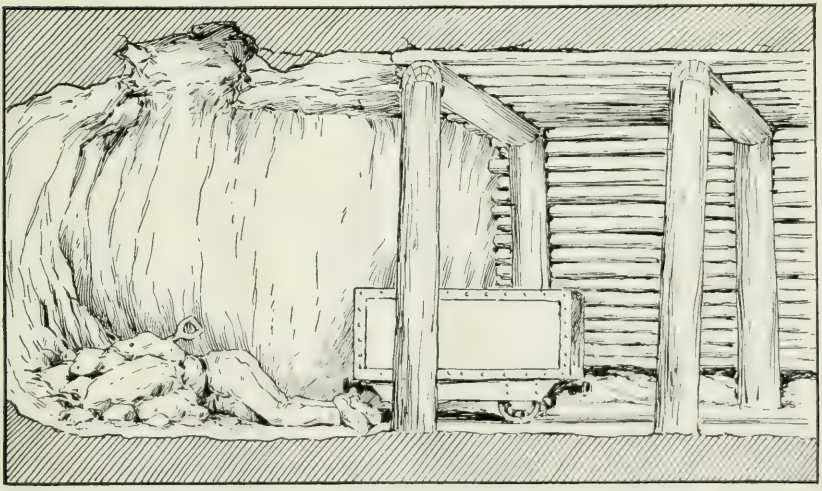


FIGURE 12.—Miner hurt by fall of rock. Don't take a chance.

[a] Higgins, Edwin, Accidents from falls of rock or ore: Miners' Circular 17, Bureau of Mines, 1914, pp. 5, 6.

Figures 13 and 14 are reproduced from the Anode, a safety-first pamphlet issued monthly by the Anaconda Copper Mining Co. Figures 34 and 35 (see pp. 49 and 50), also from the Anode, illustrate how carelessness may cause haulage accidents.

FIGURE 13.—Man using defective ladder, an unsafe practice. Any man who knows that a ladder is defective should repair it, otherwise other men, not knowing of the defect, may fall.

There is much to be gained by circulating literature and posting signs and notices printed in various languages but it is preferable that all workmen should acquire a working knowledge of the English language. The proportion of miners from continental Europe who

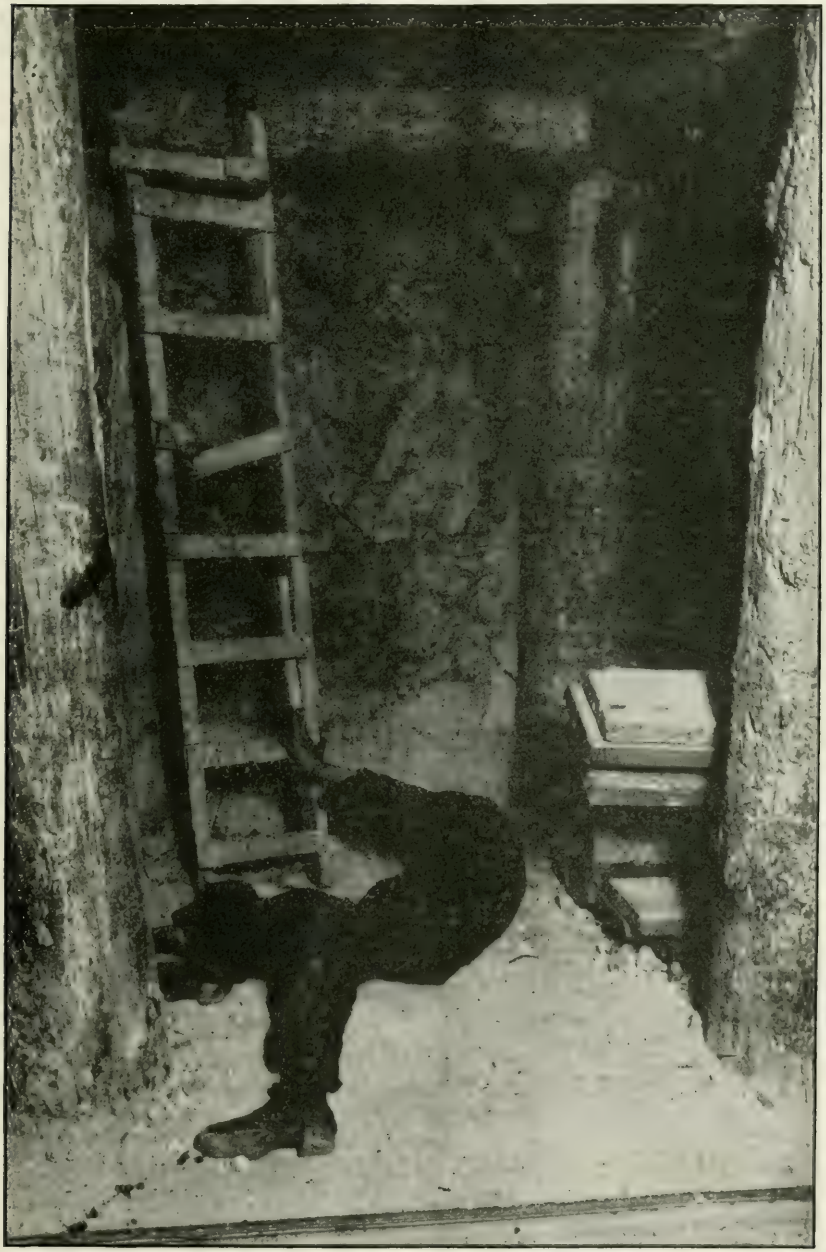


FIGURE 14.—The result, man falls from ladder.

can read and write in their own language is small. Moreover, an average group of non-English-speaking miners use a variety of dialects that differ from the literary languages of their own nations almost as much as from the literary languages of other nations. Translators always use the literary language, which may be unintelligible to an illiterate dialect-speaking miner. When the foreign workman can understand the rules and practices through his knowledge of English he is not so likely to get injured.

### POSTING RULES.

The practice of posting rules conspicuously at mines is somewhat general. For some years many companies have posted both general and specific rules to cover plant operation. Standard rules to govern employees in their performance of duties, methods of work, and handling of material have long been recognized as having a positive value in accident prevention. Wholesale disregard of such rules has resulted in many accidents that could have been easily averted, but laws and rules will not produce results unless they are enforced. A strict conformity with the spirit of the law by all employers and employees is essential for safety.

### DISTRIBUTING RULES IN HANDBOOKS.

When rules are posted efforts should be made to bring them to the attention of the workmen so that the latter may become familiar with them. Many companies print rules in several languages in pamphlet or book form and issue a book to each workman, who signs for it. A few weeks later the workman, who is expected to have read the rules or to have had them read to him, is required to send in over his signature a slip that accompanied the book, with the statement that he fully understands them. Then if he passes an oral examination satisfactorily he receives a safety button similar to that worn by members of the safety committee.

An attractive pocket memorandum book that would be of actual service to any workman would be one containing the rules of the company, safety precepts, simple problems regarding his work, and items of general interest that might cause him to refer to the book frequently and remind him of the sincere attitude of the company toward safety and the part that he must play to bring about the desired results.

A book of rules for the employees in the iron-ore mines of one company contains, among others, the following injunctions:

#### TEN COMMANDMENTS.

To Prevent Accidents and Promote Sanitation.

1. Get the safety habit. Don't take chances. Learn all the rules, understand your work thoroughly. Study the dangers incident thereto and avoid them. Think before you act.

2. Do not work with defective chains, cables, tools, or appliances of any kind, or in an unsafe place. Carefully examine same and report dangerous conditions to your foreman.

3. Never work on any machinery until you have notified the operator and attached a sign, "Danger, Do Not Move," bearing your name, at the point where the power is turned on. No man except the man who placed it should ever remove such sign.

4. Do not turn on any electricity, steam, air, or water, or set in motion any machinery, or throw down any material, without first seeing if anyone is in a position to be injured and all safety guards are in their proper place.

5. Do not handle, use, or explode any high explosive without complying with all the rules covering "High Explosives."

6. Use proper timbers and adopt all precautions to prevent any possibility of roof or sides caving in and falling on you.

7. Do not ride on or operate engines, cars, motors, steam shovels, skips, or other moving bodies, or tamper with electrical apparatus, unless authorized to do so. Never leave your regular place of work and go to another part of mine except when required by your duties.

8. If you make an opening or remove the cover from any opening in floor, ground, shaft, raise, valve pit or sewer, guard that opening so no one can fall into it.

9. Do not pile any material so high it is liable to fall or cause another pile to fall, or allow it to lean against walls too weak to bear the pressure.

10. Commit no nuisance; be clean and help to keep the mine clean. Conduct your private life so that you are at all times in the very best physical condition, wide awake, and active.

### BULLETIN BOARDS.

The use of bulletin boards (see fig. 15) for posting various items of interest, such as notices, reports, photographs, articles, has proved of great value in safety work. Such boards are in use both in and around mines. The posting of items of local interest attracts the attention of all employees. Men make it a practice to read the board daily. Figure 15 shows a group of men reading the bulletins on such a board. This illustration was supplied by the National Safety Council. Photographs showing safe and unsafe methods of work are being widely used and can be placed to advantage on the bulletin board with frequent changes and the addition of interesting data. An important item is the posting of accident reports in some such form as follows:

### REPORT OF ACCIDENT.

Mine_____
Date_____
Name_____
Occupation_____
Nationality_____
How accident happened_____
Result of accident_____
How similar accidents can be avoided_____

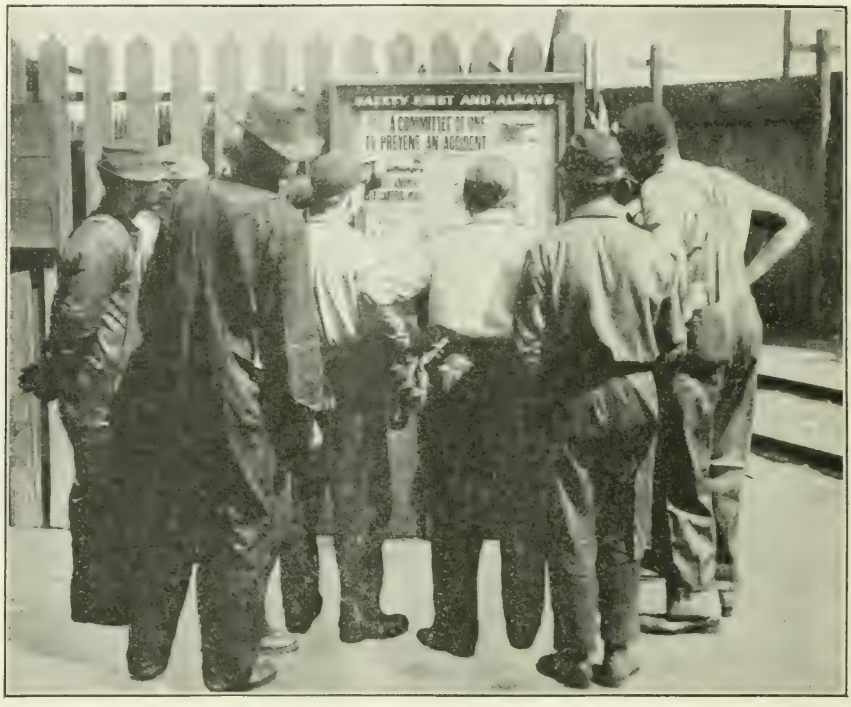



FIGURE 15.—Miners reading bulletin board.

A form of notice posted on the suggestion box at a zinc mine in New Jersey is given below:

ETERNAL VIGILANCE IS THE PRICE OF SAFETY.

Your help is wanted.

If you know of a dangerous place or machine anywhere on this plant, we want you to report it.

If you can suggest a means for safeguarding the point in question, tell us about it. You may save some one's life.

If you have no remedy, tell us of the danger anyway, and we will have others search for the remedy.

All suggestions pointing out the possibility of infection, of ill health, or of accident, to any of our employees, and also all suggestions to prevent such possibilities, should be placed in this box.

If you sign your name and number to your suggestion, we know you are trying to help us.

SAFETY COMMITTEE.

SUGGESTION BOXES.

Suggestion boxes are maintained at various plants for the receipt of suggestions and recommendations in addition to those presented by the safety committees. Information as to existing dangers, sug-

gestions for their elimination or safeguarding, or anything that in any way will tend to make conditions safer are requested. Much of direct value has resulted from this method of ascertaining the attitude of the men toward the general subject of safety. Any device or suggestion, however simple, that may prevent an accident is worthy of consideration.

In many instances notable discoveries of latent thought and ingenuity have resulted in improvements and inventions of various kinds, with benefit to both the individuals making them and to the industry. Thousands of seemingly unimportant defects which had escaped notice have been lessened or completely eliminated through suggestions received in this manner. As a concrete example of the value of this system, one of the largest industrial concerns received in two years 5,200 suggestions both from safety committees and individual employees, of which 92 per cent were adopted and put in force. Another plant received 1,200 suggestions the first year. Of these, 90 per cent are now operative, 6 per cent are being investigated, and only 4 per cent were rejected as being impractical. Figure 16 shows a suggestion box in use at an Illinois mine.

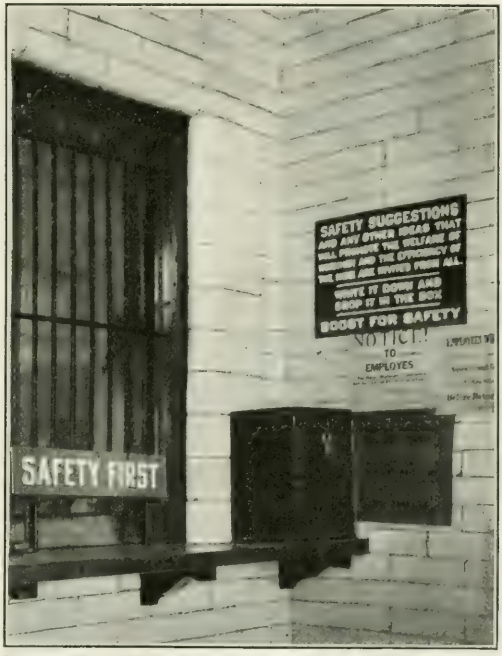



FIGURE 16.—Suggestion box used at an Illinois mine.

MEETINGS AND LECTURES.

In addition to the initial public meetings and the regular monthly meetings of the various safety committees there should be frequent public meetings, "booster meetings" for safety, in which the problem of accidents, their causes and prevention, should be openly discussed. The programs of such meetings, many of which have been held during the past two years, contain many interesting features. Lectures are given, and the desired lessons on how accidents can be avoided are taught by means of stereopticon views and motion pictures. Other forms of entertainment are provided. Such meetings finally resolve into the community life and rightfully become a part of it. The mind is forcibly impressed, and "Safety first" becomes a

common topic of conversation among the miners and their families. Wherever they meet this vital question is discussed, and the graphic tales of reckless driving, failure to set posts, setting off gas, drilling out misfires, etc., decrease in direct proportion as interest in and discussion of safety increases. Every serious accident is a reminder that something is wrong, and whether it is nonfatal or fatal is really of no consequence as far as accident prevention is concerned as a whole. Almost any serious accident might easily have proved fatal.

In the educational work carried on among the miners by the Bureau of Mines through its mine rescue stations and cars training in first aid to the injured and in mine rescue methods is supplemented by illustrated lectures on mine safety. The work has been made more effective by the use of lantern slides and motion pictures showing actual first aid and mine rescue work, tests on explosibility of coal dust, and underground mining operations in both ore and coal in detail, with practical lessons for the miner on safe and sane methods. Such a series of pictures is now available, on application to the Bureau of Mines, for use at meetings held in the interest of mining. The series of lantern slides and motion pictures is being enlarged constantly, and, as there is a suitable meeting place in practically every mining community where miners may gather, it is to be hoped that a useful purpose will be served through this medium. Information in regard to material available for purposes of this nature can be obtained from the stations or cars of the Bureau of Mines or by writing to the director of the bureau, Washington, D. C.

### SAFETY PRECEPTS.

Safety precepts are of great value in keeping the subject of safety before the minds of the men. Such precepts may be used in various forms; they may be printed on statements, pay envelopes, calendars, letterheads, or signs, or in memorandum books and special safety bulletins, or thrown on the screen during illustrated lectures. They represent in a way the policy of the company, forming practically a set of rules with supplemental admonitions. A number of precepts follow:

Safety first.

Carelessness means injury sooner or later to yourself or to others.

Report all unsafe conditions. By so doing you will prevent accidents.

Safeguards not only prevent accidents but lessen the extent of injuries which can not wholly be averted.

It takes less time to prevent an accident than to report one.

If you see a fellow workman going into a place of danger, warn him.

It is better to cause a delay than an accident.

Better be careful than crippled.

Careless workmen are dangerous in mines.

Every accident is a notice that something is wrong.

Make repairs before, not after, an accident.

Do not let loose material lie around for men to fall over.

An ounce of prevention is worth a pound of cure.

It is the little accidents that kill most.

Report all disregard of safety rules.

Nothing is a substitute for alertness and watchfulness.

A timber in place is worth a thousand on the timber pile.

Be sure you're safe, then go ahead.

It's better to be safe than sorry.

Safety first, then work in safety.

Get the safety habit.

Don't take chances with your life.

Don't gamble with your life; you might lose.

Rules are made to be followed.

Report all dangerous conditions. Be careful yourself and see that all fellow workmen exercise care.

Carefulness will avoid many accidents.

Remember that 50 per cent of the number of men killed in coal mines are killed by falls of roof, slate, and coal.

Obey instructions regarding the setting of timber.

The cooperation of foremen and workmen will greatly reduce the number of accidents.

Careful men are as a rule the most efficient.

Rules and laws are based upon experience. There are good reasons for obeying them.

Be temperate in your habits. It means greater safety and more money to you.

The prevention of accidents and injuries, by all possible means, is a personal duty which everyone owes not to himself alone but also to his fellow workmen.

Look out for the other man; you might hurt him.

Warning signs are a constant reminder that danger does exist. Obey the warning.

In case of doubt, adopt the safe course. Speed must always give way to safety.

Keep powder and caps separate.

Employees are forbidden to go into dangerous places.

Last year 424 men were killed by haulage accidents in coal mines.

We shall welcome any suggestions from employees that might assist in preventing accidents.

Each workman should consider himself a committee of one to look after his own personal safety.

One man's effort to promote safety may seem small, but the united efforts of many will be large.

The cooperation of all employees in our effort to prevent accidents is earnestly requested.

Do not carry open lights or matches into places where locked safety lamps are used.

Keep all working tools in good condition.

Do not permit boards containing protruding nails to lie around. Some one may step on them.

Nature's laws are no respecters of persons.

Examine the roof frequently.

Be sure to have every injury, no matter how slight, attended to immediately. Blood poisoning may result if you fail to do this.

The right way is always the safe way.

Let us reduce accidents at least 50 per cent.

Use as little powder as you can; it will save you money and give the company a better grade of coal.

Better be safe and sure than crippled and poor.

Use care and avoid injuries.

Be sure your roof is in safe condition before commencing work.

Be careful all the time—and you won't be sorry afterwards.

Some one's carelessness is the cause of nearly every accident—don't be the one.

Eternal vigilance insures safety.

"Safety first" put the "dent" in accident.

Fifty per cent of all accidents in coal mines are caused by falls of roof, slate, and coal. **Watch your top.**

Safety always.

COOPERATE. We
Owe it to
Ourselves and fellow workmen to
Pull together and
Endeavor to
Reduce
Accidents.
This work is for
Everybody.

## SAFETY MEASURES.

The elimination as far as possible of conditions that cause accidents, or adequate protection therefrom, is the most interesting evidence of the safety movement. In mining accident prevention covers a broad field and includes the experiences of years.

There is at present an increasing tendency to give greater consideration to the economic loss that workmen suffer by impairment of their earning capacity through accidents, and for this reason liability for personal injuries is being fixed more closely than ever upon employers of labor. Personal injuries will always accompany industrial activities, and, therefore, the worker should be considered as a part of the machinery of production, to be cared for as are other repairs or replacements. Such added cost will necessarily be borne by the consumer, inasmuch as the cost of production will be correspondingly increased.

Employers' liability laws have failed to meet the demands of modern industrial conditions. Much litigation has been caused from the various interpretations placed upon them. Employers have been subjected to hardships, whereas only a small proportion

of the injured workmen have derived any benefit, and this small proportion in turn has received only a fraction of the money actually expended in the settlement of claims. The system involves uncertainty, breeds antagonism, and always causes delay at times when immediate relief is most desirable. Such laws are now being superseded.

Workmen's compensation is coming rapidly into favor. The idea of compensation is to award a fixed sum without the necessity of litigation or the placing of responsibility for occupational injuries to workmen. The operation of such a system is intended automatically to provide immediate compensation in proportion to the wages earned and extent of the injury. Provision is usually made, however, that so-called willful or gross negligence on the part of the employer renders him liable for payment of damages, and on the part of the employee makes him forfeit his right to compensation.

Systems of workmen's compensation are in force in practically every industrial country. In the United States 33 States have enacted workmen's compensation or insurance laws. In all of these States the laws cover mining as well as other industries.

Responsibility for accidents is usually charged to hazard of the industry, negligence of worker, negligence of fellow worker, or negligence of employer. The best data available concerning the causes of industrial accidents of all kinds in Germany show that nearly 58 per cent are due to negligence of employers and employees and 42 per cent to the inevitable risks of employment. It should be noted that a large percentage of all accidents is charged to hazards of the industry. All accidents caused by unforeseen and unavoidable dangers are properly attributable to this cause, but many accidents that have been ascribed thereto could clearly have been averted, and it is believed that in the future these will be less predominant.

In view of the wonderful attainments of the safety movement in the past few years, during which time the hazard of certain industries has been greatly reduced, it is believed that all risks can be lessened. It is not to be expected that mining will ever be free from accidents, for many of its difficult problems deal with dangers peculiar to the industry, but the progress already made gives assurance that all such hazards can be greatly reduced. This reduction should in turn result in an accompanying decrease in rates of accident insurance.

### MECHANICAL SAFEGUARDS.

The subject of mechanical safeguards is usually discussed in connection with those industries, other than mining, that employ varied and complicated machinery, but the production of mineral wealth requires extensive use of it. Sawmills, machine shops, power plants, and the diverse machines required for mining ventilation, drainage, and haulage, and the preparation of coal and ore are needed at modern mining operations. To overcome the attendant dangers such requirements as the following are involved:

Protection by suitable safeguards of all exposed gears, pulleys, shafting, belting, circular saws, emery wheels, cutter bars, and trolley wires;

Elimination of projecting set screws, bolts, or keys on revolving shafts;

Loose pulleys for belt-driven machines and more extensive use of direct-connected machinery;

Wearing of close-fitting clothing by persons working around gears and revolving parts of machines;

Fly wheels fenced off;

Ample clearance space and light;

Passageways kept free from obstructions;

Railings in connection with stairways and overhead walks;

Free use of signs of danger, instruction, and caution;

Protection from dangers attending use of steam, electricity, and compressed air;

Safe mechanical equipment in good repair.

A number of safety devices in use at mines are shown in figures 17 to 27. A portable steel safety house for protecting men at open-pit mines from flying rock during a blast is shown in figure 17. Figure 18 shows a powder shield for loading holes at open-pit mines to prevent powder from spilling and to protect it from sparks from locomotives. Figures 19 and 20 were furnished by courtesy of the Department of Labor. They show a safety lock for boiler valves and types of guards for lathes and emery wheels. Figures 21 and 22 show types of gates in use at some shaft mines; figure 23 shows a warning sign on the headframe of a mine in Montana. A safety cover placed over the pulley on a self-dumping bucket used in Alaska gold-mining operations is shown in figure 24. This serves to protect workmen from having their fingers cut off in the pulley when being hoisted; the bucket swings rather freely in the shaft. A safety device for ladders is shown in figure 25. A number of safety devices at mines are shown in Technical Paper 30.[a] Figure 26 shows a life line for use by mine-rescue parties wearing mine-rescue apparatus. Figure 27 shows standard timbering as a safety precaution in a mine where excellent roof conditions are present.

[a] Woodbridge, D. E., Mine-accident prevention at Lake Superior iron mines: Tech. Paper 30, 1913, 36 pp.

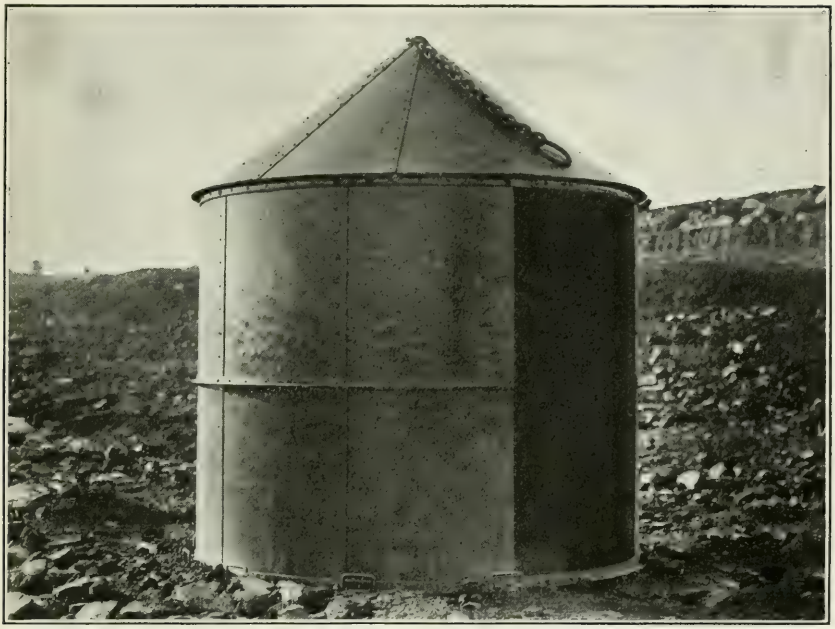


FIGURE 17.—Steel safety house used at open-pit mine in Minnesota to protect workmen from flying rock after a blast.

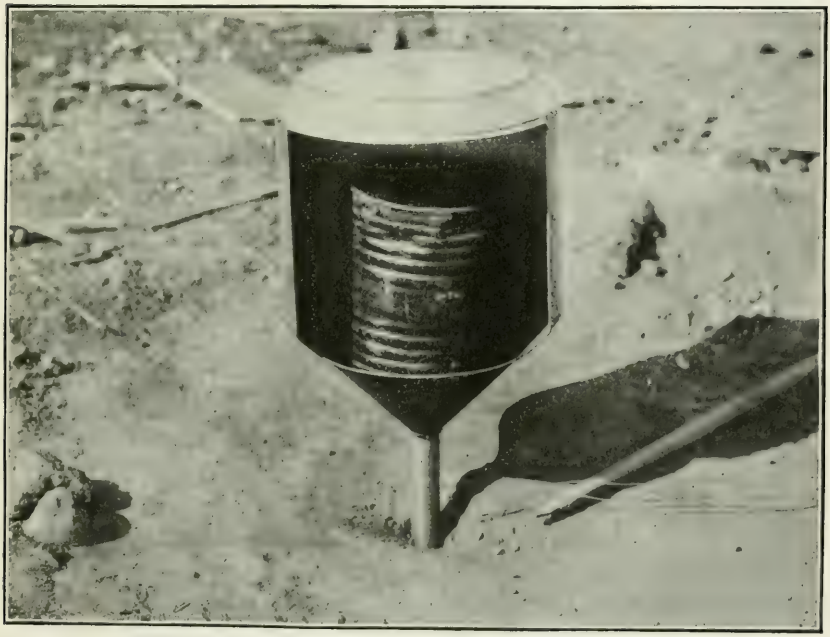


FIGURE 18.—Powder shield for loading holes at open-pit mines.

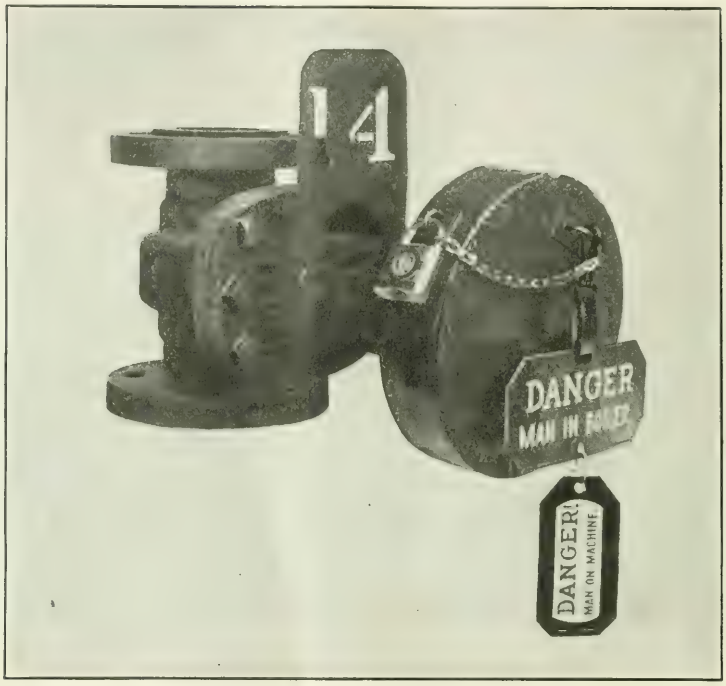



FIGURE 19.—Boiler valve closed and locked.

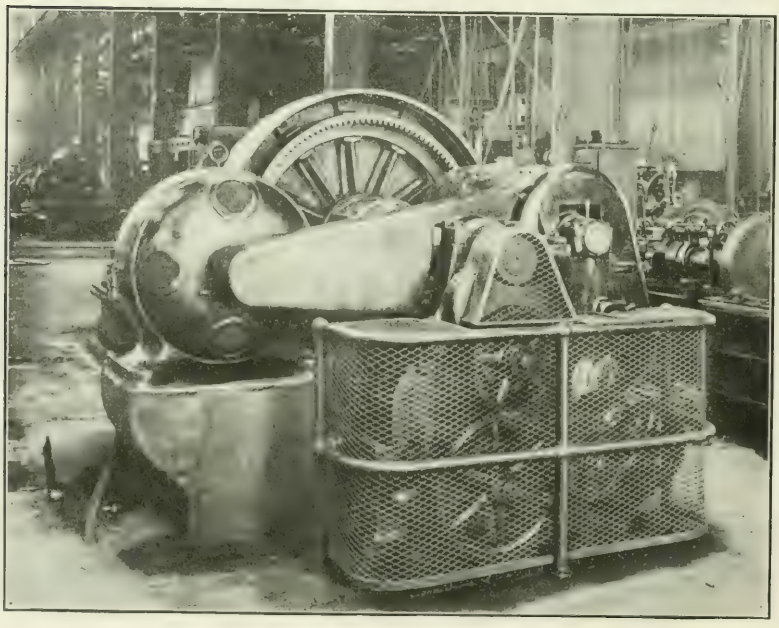


FIGURE 20.—Lathe, with covered gears.

The construction and application of safeguards is a matter that frequently demands considerable mechanical ingenuity and skill, but

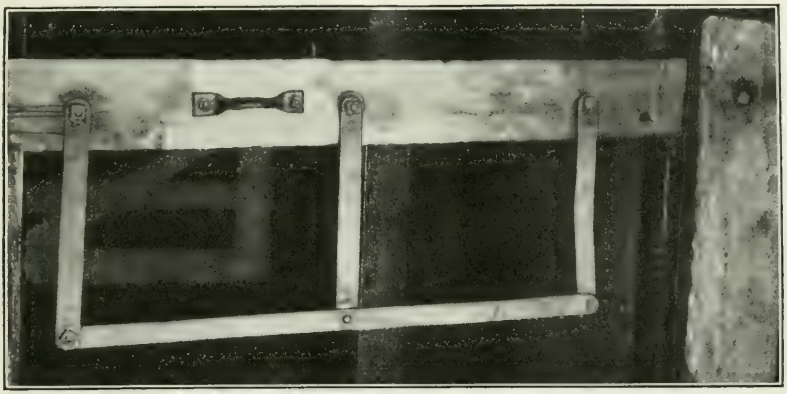


FIGURE 21.—Type of gate at third level of a Michigan mine.

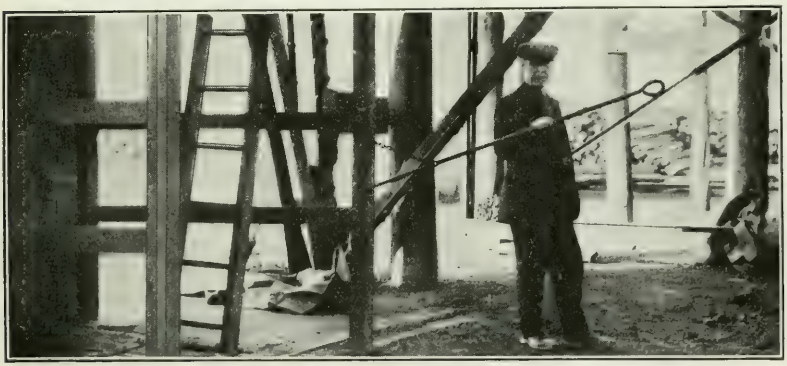


FIGURE 22.—Self-closing bar gate, open.

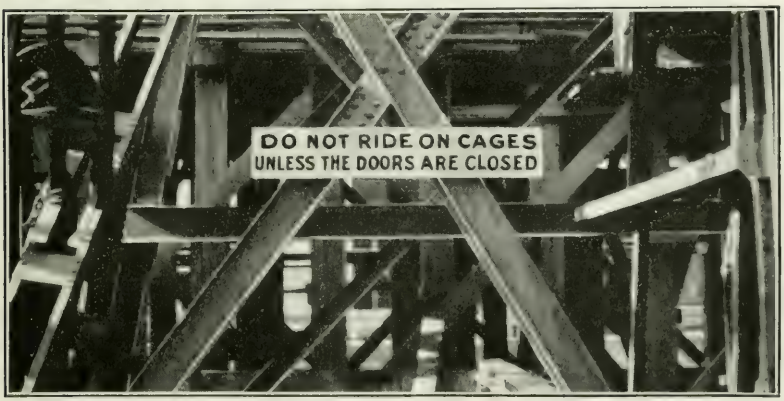



FIGURE 23.—Warning sign used on headframe of a Montana mine.

often some simple homemade device will meet the requirements. A safeguard should be so constructed that it forms a part of the ma-

chine. It should be practicable, adjustable when necessary, give the desired protection without interfering with efficient operation, and be kept in good repair. Heretofore too little attention has been given in designing machinery to guarding the movable parts that may cause and have caused numerous accidents, but the present tendency is to require such specifications in the design and to favor manufacturers of well-guarded machines, as well as to standardize the safety devices on machinery common to any industry. Sometimes the construction is such that the machine can not be operated unless the guard is in its proper position, and for the larger machines, such as engines, air compressors, generators, boilers, and hoists, automatic-control devices are provided.

FIGURE 24.—Protective device on pulley of self-dumping bucket used at a placer mine working frozen gravel in Alaska; shaft about 50 feet deep.

SIGNS.

The favorable attitude of the management toward safety can not be better shown than in a free use of signs consisting of various wordings and emblems for guidance and warning, both in and around mines. Warning signs judiciously used will tend to prevent accidents, as they are a constant reminder that danger does exist. Especially should all dangerous places be pointed out by means of some well-known warning sign. To be forewarned is to be forearmed. A sign, however, should not take the place of a positive removal of the danger.

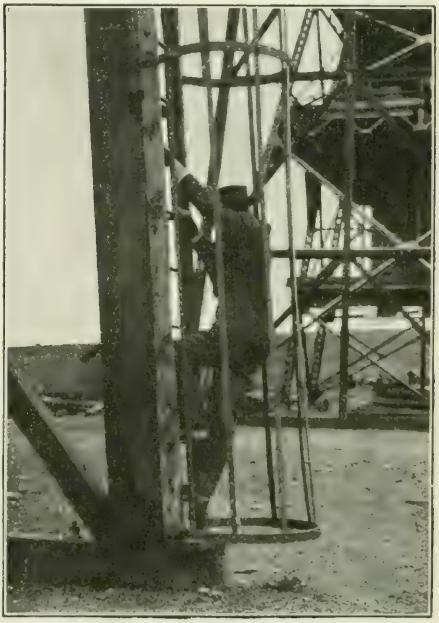


FIGURE 25.—Safety device for ladders used at a Michigan mine.

Man is disposed to use simple signs and emblems for danger, direction, and caution, such as a pointing arrow or hand for direction and red for danger. The simplest sign is usually the best, and one

that is self-explanatory without lettering is of most value, especially to non-English-speaking miners.

Conditions frequently arise whereby certain sections or places in a mine become dangerous, as through accumulations of gas or through bad roof, and men must be prevented from entering. The Depart-

FIGURE 26.—Use of life line with mine rescue apparatus.

ment of Mines of Pennsylvania has adopted a penalty danger sign to keep men out of such dangerous places. When so used, this sign must not be passed. Its use, therefore, is restricted to a special purpose, thus a clear distinction is made between a sign of mere warning and one designating positive danger.

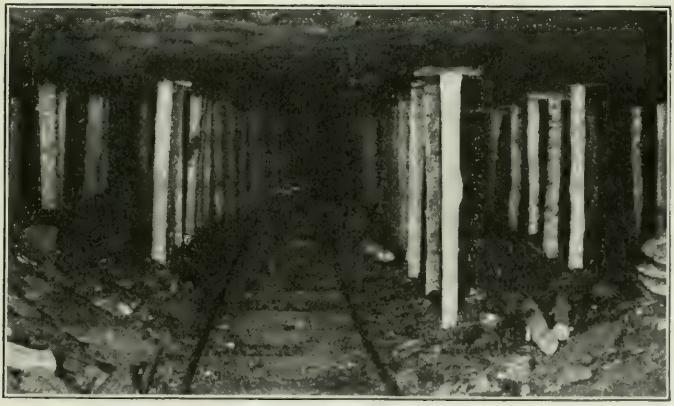


FIGURE 27.—Standard timbering as a safety precaution in a mine in which roof conditions are excellent.

A large electric sign in an Idaho mine is illustrated in figure 28. The danger sign used in a Pennsylvania coal mine to prevent motormen with a trip or miners from entering an unexamined part of the mine, or a part that is temporarily dangerous, is shown in figure 29. Figure 30 shows the method employed in a coal mine in southern

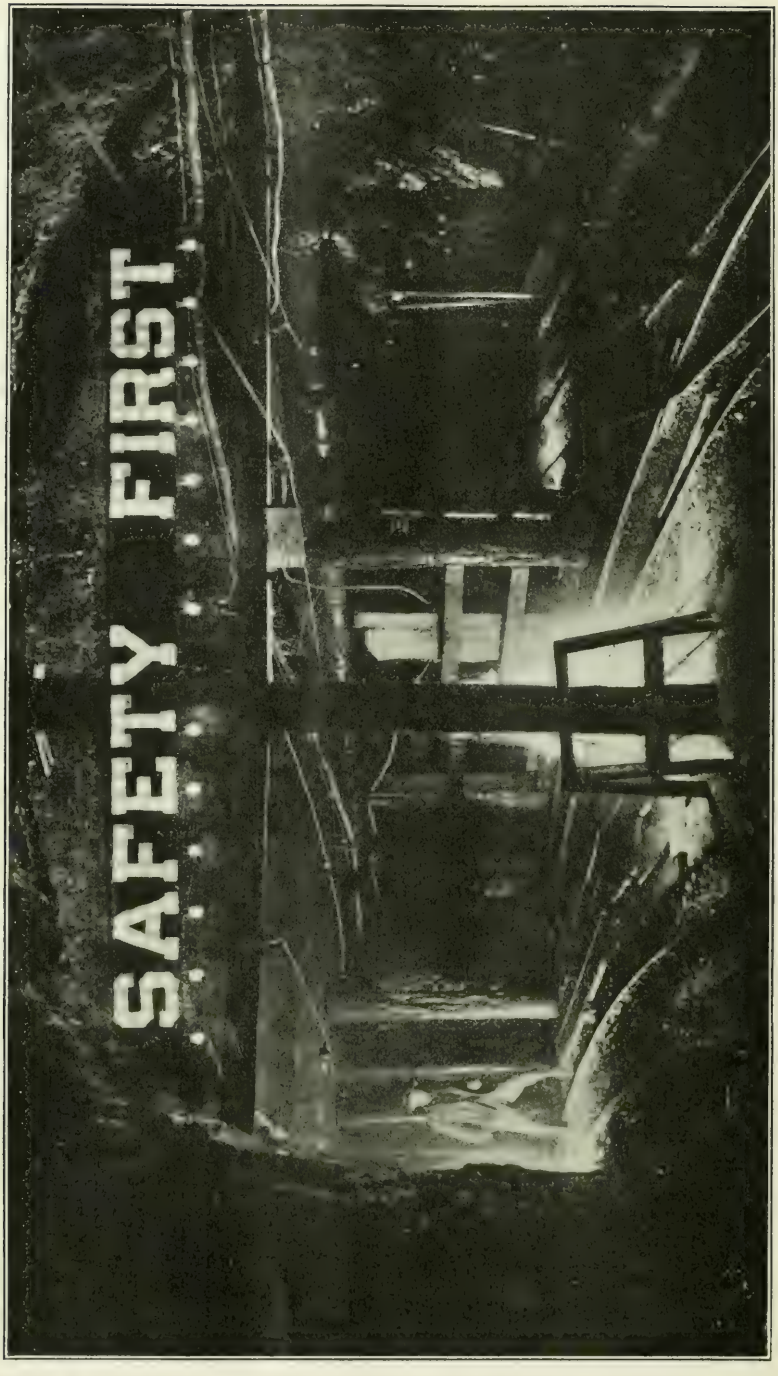



FIGURE 28.—Electric sign, "Safety first," two miles from portal of mine in Idaho.

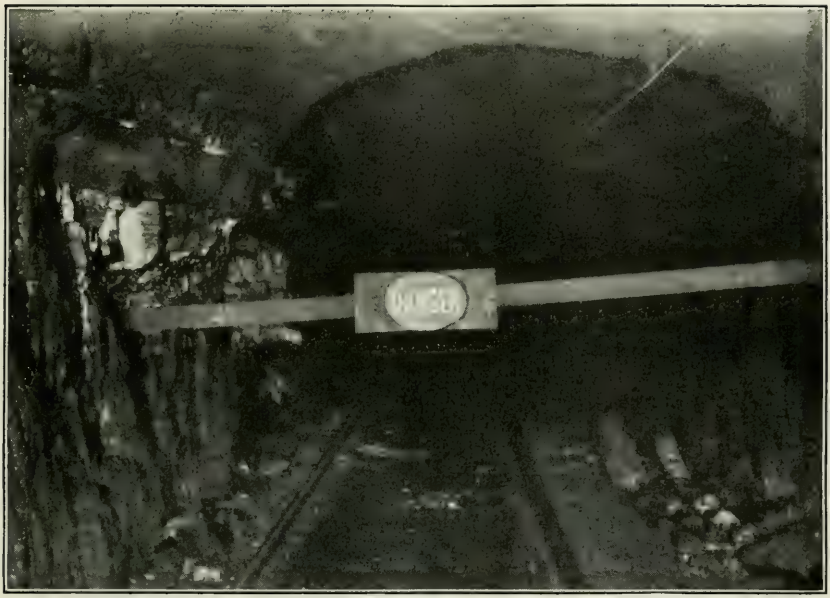


FIGURE 29.—Danger sign in Pennsylvania coal mine.

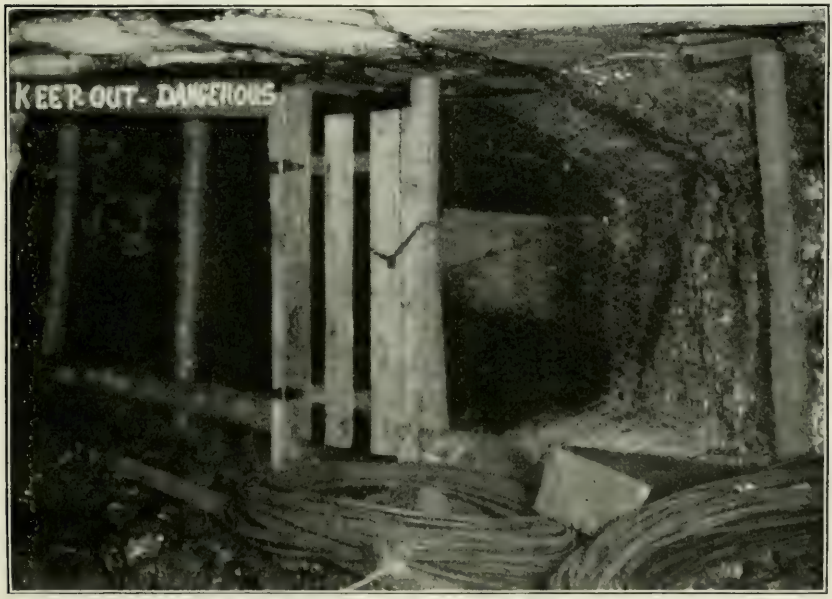



FIGURE 30.—Method used in Illinois mine to fence off old workings without interfering with ventilation.

Illinois to fence off old workings without interfering with the ventilation. Wire netting is used and the gate is kept locked. A safety sign placed over the door of the superintendent's office at a copper mine in Nevada is shown in figure 31. A signboard in a Lake Superior iron mine is shown in figure 32.

Types of signs used at mines pointing out various dangers and signs recommended by the Bureau of Mines are illustrated in Technical Paper 67.[a]

CAUTION SAFETY FIRST
UNLESS WILLING TO BE CAREFUL
AND AVOID INJURIES TO YOURSELF AND
FELLOW WORKMEN DO NOT ASK
FOR EMPLOYMENT. WE DO NOT
WANT CARLESS MEN IN OUR
EMPLOY.

FIGURE 31.—Safety sign on door of superintendent's office at copper mine in Nevada.

Systematic posting of signs throughout the mine wherever they may be of aid has been carried out in a number of cases. Men temporarily lost in extensive workings may find their way out of the mine by noting the direction of air current, switches, flow of water, etc., but to do so requires more or less familiarity with the workings. Systematically posted signs giving the location and direction, such as "Third level," "This way to shaft," "This way out," have a direct value in the saving of much time, especially with new men unaccustomed to a particular mine, and undoubtedly in time of disaster when men become confused, would aid greatly in the escape of survivors or assist in any subsequent rescue work.

Durable signs, such as those of rolled steel with fused enamel letters, can be purchased from various manufacturers at a nominal cost. The bureau will furnish on application information regarding manufacturers of standard safety signs. An economical method for making signs that can be employed by any company is with stencils or patterns cut out of stiff durable cardboard. A pattern of any desirable size can be made with suitable wording and emblem. When the stencils are completed it is easy to furnish a quantity of signs with the use of a few feet of properly planed lumber, three colors of paint, and brushes, using the most widely adopted style, black background, white letters, white arrow, and solid red circle.

[a] Higgins, Edwin, and Steidle, Edward, Mine signboards: Tech. Paper 67, Bureau of Mines, 1913, 15 pp.

Another method is by blue prints of tracings. These blue prints can be used in making very effective illuminated signs or in displaying rules and notices in suitable frames.

### GENERAL PRECAUTIONS.

In addition to safeguards against the dangers attending the use of machinery and other mechanical equipment, many protective devices, such as goggles to protect the eyes from flying chips, shields to protect parts of the body, respirators to prevent inhalation of dust, exhausts for confining dust, are provided. The value of any safeguard

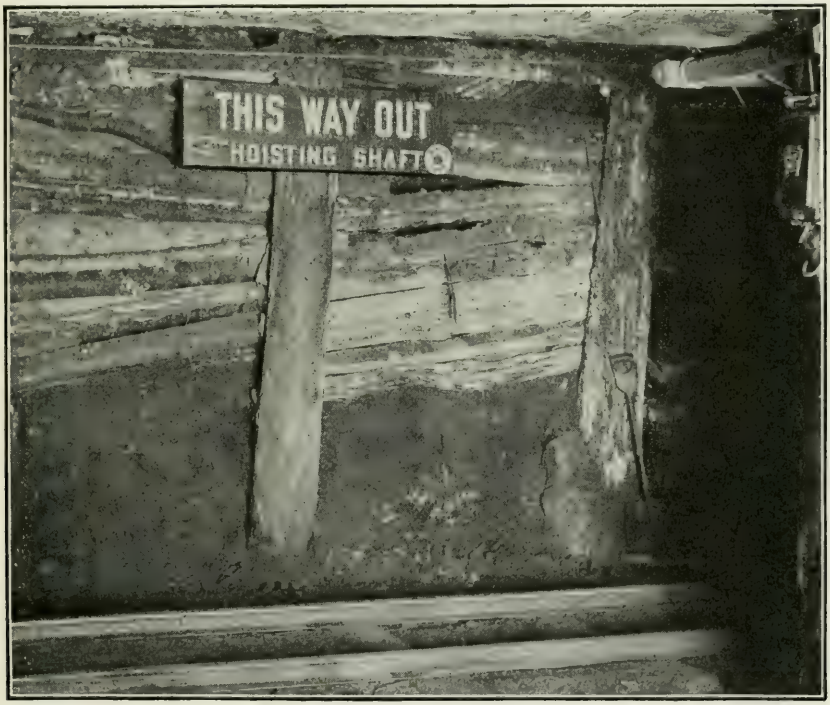



FIGURE 32.—Signboard in a Lake Superior iron mine.

depends on its intelligent use, and for this reason education goes hand in hand with safeguards in the prevention of accidents. Well-defined standards for ventilation, timbering, explosives, shot firing, track work, electric work, and inspection in conjunction with safe practices are the important requirements.

Safeguarding is not intended to eliminate the need of personal thought and alertness, as careful men are always better than safety devices, but is essential for the protection of workmen who carelessly or unavoidably expose themselves to existing dangers. Besides, it has a marked tendency to cause men to cultivate habits of care.

The safeguarding of machines has to do with the safety of the individual employees. Mining requires safeguards that have to do

with the safety of the entire working force, such as guarding against mine fires and explosions. Given a sufficient number of elements and conditions, approximating a danger limit and favorable to an explosion or fire, there may arise at any moment a combination of circum-

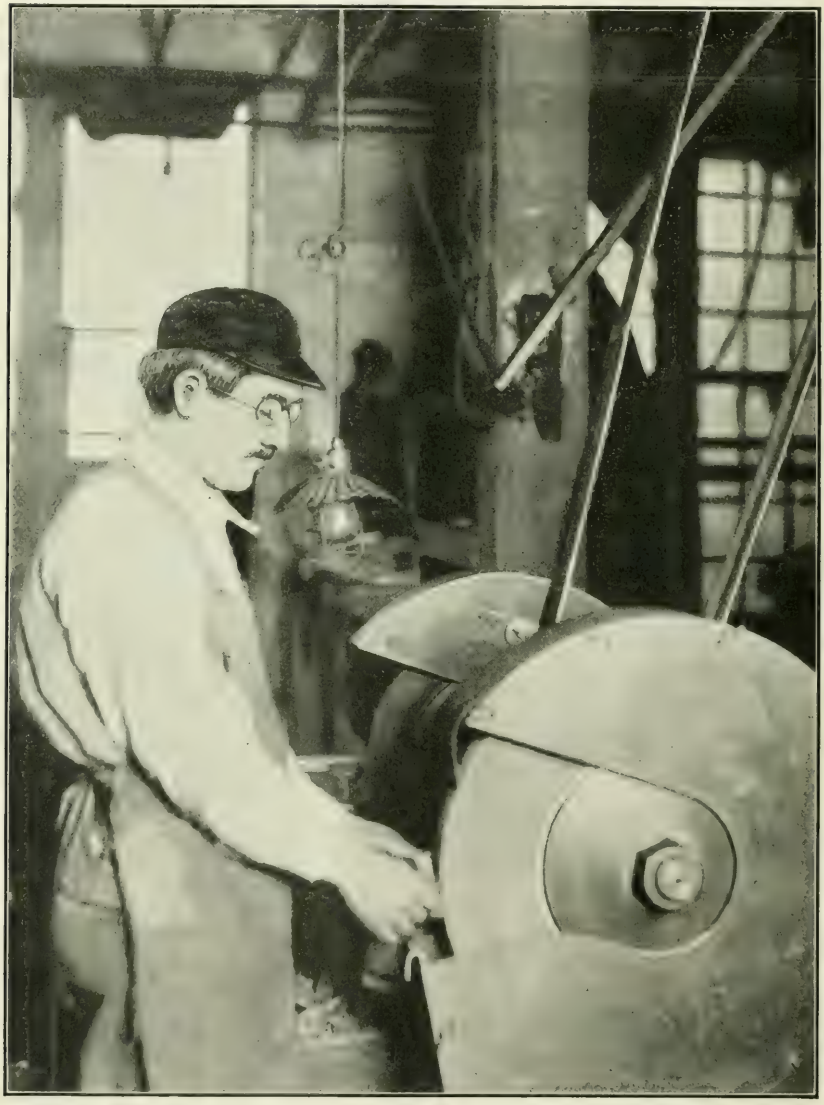


FIGURE 33.—Guarded emery wheel for grinding tools. Workman wearing goggles.

stances that can furnish the additional factor necessary to initiate a frightful disaster. Safety measures against such conditions are highly desirable. Under this head are included for coal mines adequate ventilation, the use of improved types of locked safety lamps or per-

missible electric cap lamps in gaseous mines, explosion-proof motors, permissible explosives, safe methods of handling and transporting

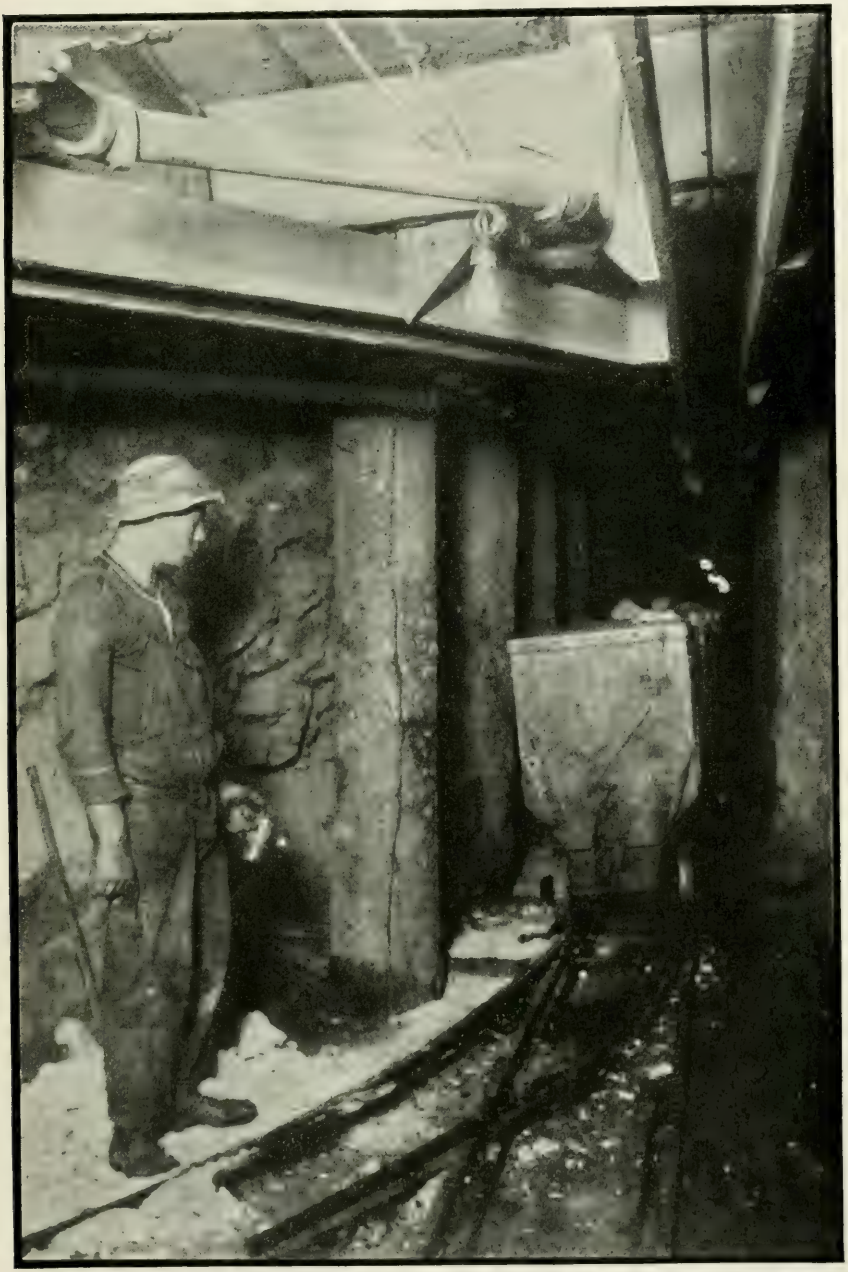


FIGURE 34.—Unsafe practice—miner standing where he may be injured by car.

explosives, restricted use of electricity in gaseous mines, immunizing or eliminating coal dust, use of incombustible material in construc-

tion work, adequate fire protection, and mine rescue and first-aid organization. These subjects have been fully treated in other publications of the Bureau of Mines, to which reference should be made.

FIGURE 35.—The result, miner gets caught by car.

Figures 34 and 35, from the Anode, illustrate how haulage accidents may be caused by lack of care on the part of the miner.

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